NYASALAND PROTECTORATE

Annual Report

of the

Department of Agriculture

for the

Year 1961/62

(PART II)

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COMMONWEALTH MYCOLOGICAL INSTITUTE
30 DEC 1963

PRICE 10s

1963

PRINTED AND PUBLISHED BY THE GOVERNMENT PRINTER
ZOMBA, NYASALAND

AGRI. 11785/650/10 63

DEPARTMENT OF AGRICULTURE
ANNUAL REPORT FOR THE YEAR 1961/62
(PART II)

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INTRODUCTION

Few farmers in Africa will admit that they ever experience " normal " weather in the growing season and similarly the Research and Experiment division of the Department has not had a " normal " complement of officers for some years now. The gaps in the ranks are very noticeable and in this report there are no sections on Tung, Coffee, Fruit and Vegetables or Grasslands. The work, however, has gone on and it has been possible to record the experiments on all the perennial crops but it has not been possible to prepare the results for publication. It is intended that they will be included in next year's report.

The report is presented by crops and each part may be the work of more than one author. Much of the work of specialists is reported under the crop headings and reference should be made to these sections as well as in the specialist heading.

Steady, if unspectacular, progress has been made on a number of crops. A few new maize varieties are emerging to take their place among the established types that have been bred at Chitedze. It is disappointing that although their yield is distinctly better than unselected local maize there is very little enthusiasm for planting them. Groundnuts are a difficult crop to improve and again the introduction of the better varieties into widescale production is extremely slow, as is also the use of the right spacing to ensure good yields. The tobacco crop was generally of higher quality than usual but the underlying reasons for the decline in quality over the past 20 years still await solution. A survey of the industry was made by Dr. J. O. Andes of Tennessee University.

There was a record crop of cotton and the spraying trials were again successful showing that economic increases in yield can be obtained if there is good cultivation and the sprays are applied consistently. The work on the control of *Fusarium* on coffee continues and as control will probably depend on the selection of resistant varieties it is obviously a project that will take many years to reach completion. The experimental cocoa plots continue to grow well and next season there should be enough pods ripe at one time to give sufficient quantity of beans for a normal fermentation. Germination of seeds in the pod and too small a bean give difficulty but these faults may be an expression of the very rapid maturity of the trees and will disappear with time.

A lot of information is being accumulated on sugar with varietal trials and experiments on different dates of planting and varying amount of irrigation water. The essential oil plant Ninde was sown for the first time and gave fair yields and it remains to be seen how well it will grow in succeeding years. The long term rotation experiments laid down some years ago are yielding valuable information with, as might be expected, somewhat different results on varying soil types.

LIST OF EXPERIMENT STATIONS AND STAFF LIST

The experiment stations in operation during the period under review, and the officers who have been in residence, are listed below:

Agricultural Research Station, Chitedze, Box 158, Lilongwe

Senior Agricultural Research Officer ..	H. B. AMBROSE, B.SC. (AGRIC.) (LOND.), DIP. AGRIC. (CANTAB.)
Agricultural Officer (Tobacco) ..	D. E. EDMOND, B.SC. (LEEDS), DIP. AGRIC. (CANTAB.), D.T.A. (TRIN.)
Agricultural Officer (Agronomy) ..	P. BROWN, B.A. (CANTAB.), D.T.A.
Plant Breeder	P. KYLE, B.SC. (HONS.) (WALES)
Agricultural Chemist	R. A. WOOD, B.SC. (MANCH.)
Assistant Chemist	W. D. CHONA, B.SC. (RHODES)
Farm Manager	C. P. MIDDLEMISS, B.SC. (LEEDS), D.T.A. (TRIN.)

Bvumbwe Tung and Agricultural Experiment Station, Box 748, Limbe

Agricultural Officer	L. J. FOSTER, B.SC. (READING) J. HILL, B.SC. (READING), D.T.A.
Senior Agricultural Chemist	C. V. CUTTING, B.SC. (LOND.), PH.D., A.R.I.C.
Plant Pathologist (Coffee Research) ..	M. A. SIDDIQI, M.SC. (ALIGARH), PH.D (WALES)
Laboratory Technician	R. C. PEAK, F.I.S.T.
Farm Manager	F. HIGSON

Tuchila Experiment Station, Box 28, Luchenza

Officer in Charge	J. A. SEAGO, N.D.A., C.D.A.

Makanga Experiment Station, Chiromo

Agricultural Officer	J. T. W. GRAY, B.SC. (AGRIC.) (BELFAST)
Farm Manager	D. F. COLLINGS, C.D.A.

Mwera Hill Experiment Station, Dowa

Officer in Charge	I. K. MSISKA

Chitala Experiment Station, Salima

Officer in Charge	Y. J. KAMPONDA

Mbawa Experiment Station, Mzimba

Officer in Charge	G. D. HORSPOOL, N.D.A., C.D.A.

Provincial Agricultural Officers

Southern Province	F. E. LUSCOMBE, B.SC. (READING), A.I.C.T.A.
Central Province	J. EVANS, B.SC. (READING)
Northern Province	R. J. HARVIE, B.SC. (ALBERTA), D.T.A. E. T. WILMOT, M.A., DIP. AGRIC. (CANTAB.)

Headquarters, Zomba

Chief Agricultural Research Officer ..	S. T. HOYLE, O.B.E., M.A. (CANTAB.), A.I.C.T.A.
Entomologist	R. C. H. SWEENEY, M.I.BIOL., F.R.E.S.
Ecologist	B. STEELE, B.SC., PH.D. (READING)
Plant Pathologist	D. C. M. CORBETT, B.SC. (HONS.) (ABERD.), DIP. AGRIC. SC. (CANTAB.), D.T.A. (TRIN.)
Soil Surveyor	A. YOUNG, M.A. (CANTAB.), PH.D. (SHEFFIELD)

Cotton Pest Research Scheme

Officer in Charge (Gatooma)	J. P. TUNSTALL, B.SC. (HONS.), DIP. AGRIC. (READING), A.R.C.S.
Entomologist	G. A. MATTHEWS, B.SC., A.R.C.S., F.R.E.S.
Entomologist (Makanga)	D. J. MCKINLEY, B.SC. (LOND.)
Technical Assistant (Gatooma) ..	A. A. K. RHODES

MAIZE

Breeding Work

1. GENERAL

This report covers two seasons during which, in the absence of a plant breeder, work was primarily concerned with the continued testing of previously produced varieties. Development work was limited.

Both seasons were favourable for maize production in the Lilongwe area and at Mbawa in the Mzimba District. In particular 1961/62 produced some of the highest yields ever recorded at Chitedze but this second year was much less favourable on the Lake-shore at Chitala and at Tuchila in the Southern Province.

The majority of the formal experiments were carried out on Kandiani series soils at Chitedze. Plot sizes are indicated for each experiment. The plots consist in each case of single rows, either five or ten yards long, with three feet between rows and one foot between plants, spaced singly in the rows.

2. INBREEDING AND TESTING INBRED LINES

1960/61:

The most advanced group of inbreds grew as S.11 plants. Fifty-seven S.9 generation inbred lines crossed with N.2656 in 1959/60 formed the basis of a yield trial this year. The object was to find a replacement, with better tip coverage and grain quality, for single cross 93 which pairs with single cross 110 in the production of of the double hybrid Mthenga, LH No. 7.

The trial was put down as six replications of a randomized block with single row plots, each five yards long. It gave a mean yield of 8,259 lb. per acre with a coefficient of variation of 16.6 per cent.

Single cross 93 was used as the control, and was significantly outyielded at the five per cent. level of probability by one cross only, whilst 47 crosses were not significantly different from it at the same level of probability. Eight crosses which yielded at a level similar to single cross 93 were found to be superior in tip coverage and flintiness of grain, so these passed forward for further testing.

1961/62:

The most advanced group of inbreds grew as S.12 plants. The best single crosses from the 1959/60 Hybrid Yield Trial were crossed in various combinations, at Chitala during the dry season of 1961. The object of these crosses was firstly to find a replacement for single cross 110 (L4161 × Mex 20) which is a difficult cross to make owing to the poor late growth of L4161, and secondly to persist with SC.110 in spite of its difficulties of making and attempt further crosses with it that might be better in tip coverage and grain character than Mthenga. The resulting crosses from Chitala formed the basis of this year's Hybrid Yield Trial.

3. MAIZE VARIETY TRIALS

1960/61:

These trials were sited at four stations only this year, Makanga being omitted. There were six randomized block replications at each site, the plots consisting of a single row, ten yards long. The coefficient of variation was high at Chitala, medium to low at other stations. The results are given in Table I.

At all stations the top yielders, as was the case last year, were to be found mainly in the local hybrids numbers 10, 11 and 12. Mthenga, Local hybrid No. 7, yielded well on average, and in conjunction with its superior characters of tip coverage and flinty grain, further justified its choice as the first hybrid to be multiplied for issue in the country.

The Synthetic varieties again included a number of high yielders, although Synthetic variety No. 21, which gave good yields over the past two years did not continue its high performance except at Tuchila. Synthetic varieties Nos. 34 to 39 however, have again returned high yields at Chitedze, and deserve further testing at other sites.

1961/62:

These trials were again held at four stations as in the previous year, the layout being the usual randomized block with six replications, each plot consisting of a single row, ten yards long. The coefficient of variation was very high at Tuchila and Mbawa, Chitedze and Chitala showing a slight decrease over last year. The results are given in Table IA.

Following the last two years trend, the top yielders at all sites were to be found in the group of local hybrids Nos. 7 to 12. Local hybrid No. 11 was outstanding at Chitedze and Mbawa, outyielding its nearest rival by over 1,000 lb. A bulk pollinated F_1 generation of Local hybrid No. 7 did not significantly outyield a comparable hand-pollinated crop, although the mean increase of bulk over hand-pollinated for all stations was in the region of 500 lb. per acre.

Synthetic variety No. 21 performed well at Tuchila and Mbawa, and Nos. 21, 31 and 32 very well at Chitala. Two new crosses namely Single cross 93 × Local hybrid 10, and Single cross 100 × Synthetic variety 21, performed very well at Chitedze, and are to be tested at all stations next year.

4. FURTHER ASSESSMENT OF VARIETIES

Table II shows Tip Coverage and Grain Character scores for the present leading varieties. The scores are means taken from all or some of the following trials:

Maize Variety Trials 1959/60; 1960/61; 1961/62.

Synthetic Variety Trials 1959/60; 1960/61.

The mean yields shown are taken from the same trials.

The importance of tip coverage is that it impedes cob infestation by the grain weevil, *Calandra oryzae* both in the field and in storage. This is the only means, until Nyasaland African farmers use insecticide in grain stores, of protecting cobs from from attack. Hard, flint, grain slows down weevil depredation once they are in the cob and is, in any case, preferred to dent types by African consumers as giving a higher proportion of white flour (R. T. Ellis, Food Properties of Flint and Dent Maize, E.A.A.J. Vol. XXIV No. 4).

TABLE I

Maize Variety Trials 1960/61

(Yields of grain in lb. per acre)

Variety	Chitedze Site I	Chitala Site II	Mbawa Site III	Tuchila Site IV
1. Local Unselected	5,149	2,502	3,599	5,455
2. Namlenga	6,359	4,027	4,059*	5,641
3. LH No. 2 F_1	5,471	3,866	4,317*	5,714*
4. ,, F_2	5,237	2,260	3,535	3,406
5. ,, F_4	4,551	2,558	3,486	4,261
6. LH No. 7 F_1	6,851	4,737	5,020*	5,649
7. ,, F_2	5,665	4,584	3,446	5,714
8. ,, F_3	5,722	4,196	3,753	5,544
9. LH No. 10 F_1	7,061*	4,398	4,519*	5,907*
10. ,, F_2	6,787	4,083	3,890	6,198*
11. ,, F_3	6,698	4,059	4,277*	5,948*
12. LH No. 11 F_1	7,836*	4,624	4,947*	6,714*
13. ,, F_2	7,562*	3,890	4,430*	5,601
14. LH No. 12 F_1	6,997*	4,551	3,914	5,617
15. ,, F_2	6,876	3,874	3,163	5,778*
16. ,, F_3	5,601	3,632	3,414	5,326
17. Mlonda GTC	5,584	4,326	3,946	5,197
18. Synthetic Variety 8	6,190	3,841	4,003	5,052
19. ,, 15	6,698	3,599	4,455*	5,294
20. ,, 16	6,400	4,390	3,987	5,617
21. ,, 17	6,375	3,664	4,148	5,358
22. ,, 21	5,318	3,922	3,785	5,738*
23. ,, 22	5,843	3,260	4,124	5,189
24. ,, 23	5,552	2,695	3,180	4,293
25. ,, 26	6,093	4,341	2,961	5,794*
26. ,, 27	6,391	4,600	3,632	5,810*
27. ,, 28	5,940	4,632	4,406*	5,697
28. ,, 29	6,690	4,422	4,945*	5,706*
29. ,, 30	6,287	4,213	4,495*	5,221
30. ,, 31	6,488	4,907*	4,011	5,310
31. ,, 32	6,545	3,293	4,342*	5,584
32. ,, 33	6,690	2,736	—	—
33. ,, 34	7,061*	5,802	—	—
34. ,, 35	7,981*	4,463	—	—
35. ,, 36	7,507*	4,535	—	—
36. ,, 37	7,957*	4,366	—	—
37. ,, 38	6,884	3,825	—	—
38. ,, 39	7,723*	4,043	—	—
39. ,, 40	5,496	2,203	—	—
40. ,, 24	5,891	3,793	—	—
41. ,, 25	4,430	2,865	—	—
42. Mlonda F_1	5,302	3,293	3,123	5,318
43. F_2	5,738	3,970	3,841	4,858
44. F_3	6,069	4,237	4,003	5,092
45. F_4	6,101	3,761	4,269*	5,358
46. Mthenga × GTC F_1	4,858	4,003	3,034	5,189
Mean	6,289	3,909	3,929	5,453
Least Significant Diff. 5%	920 lb.	1,033 lb.	842 lb.	1,012 lb.
,, ,, 1%	1,202 lb.	1,356 lb.	1,109 lb.	1,328 lb.
Coefficient of Variation	12.8%	23.0%	17.0%	16.4%

* Top yielding varieties not differing significantly from the highest yielder at the 5 per cent. probability point.

TABLE IA

Maize Variety Trials 1961/62

(*Yields of grain on lb. per acre*)

	Variety	*Chitedze*	*Chitala*	*Mbawa*	*Tuchila*
1.	Local Unselected	5,857	1,371	3,921	3,280
2.	Namlenga	6,575	976	4,251	1,370
3.	Local Hybrid No. 2 F_1	6,857	1,267	4,316	3,305
4.	,, ,, 7 F_1 Hand	8,688	1,783	5,720	3,837*
5.	,, ,, 7 F_1 Bulk	9,358	2,275	6,357*	3,982*
6.	,, ,, F_3	7,010	1,460	4,751	3,047
7.	,, ,, F_4	7,599	1,283	4,106	3,200
8.	,, ,, No. 10 F_1	9,003	1,428	5,800	3,579
9.	,, ,, No. 11 F_1	10,753	1,759	7,406	4,643
10.	,, ,, No. 12 F_1	8,632	2,041*	6,301*	3,417
11.	Synthetic Variety 12	6,720	1,283	4,606	2,571
12.	,, ,, 15	7,212	1,339	4,445	2,716
13.	,, ,, 16	7,220	1,872	4,969	2,208
14.	,, ,, 17	7,583	1,726	5,098	2,660
15.	,, ,, 18	6,954	1,000	4,574	3,039
16.	,, ,, 19	7,551	1,331	5,461	2,990
17.	,, ,, 21	7,333	1,759	5,397	3,530
18.	,, ,, 22	6,800	1,412	4,114	2,523
19.	,, ,, 27	7,631	1,791	4,816	2,273
20.	,, ,, 28	6,502	1,751	4,558	2,184
21.	,, ,, 29	7,906	1,218	4,937	1,531
22.	,, ,, 31	7,172	1,928*	4,461	1,604
23.	,, ,, 32	6,462	1,872	4,864	2,217
24.	,, ,, 38	4,993	1,202	3,848	2,104
25.	,, ,, 40	7,147	1,178	3,985	2,998
26.	Mlonda F 5	7,575	1,654	4,711	3,329
27.	Mlonda GTC	7,172	1,646	4,074	2,426
28.	S.V.7 F 5	5,897	831	4,388	1,749
29.	SC. 93 × LH 10	7,631	—	—	—
30.	SC. 110 × SV 21	8,527	—	—	—
	Mean	7,404	1,515	4,865	2,796
	Least Significant Diff. 5%	976 lb.	385 lb.	1,129 lb.	814 lb.
	,, ,, ,, 1%	1,290 lb.	510 lb.	1,484 lb.	1,072 lb.
	Coefficient of Variation	11.7%	22.4%	20.3%	25.9%

* Top yielding varieties, not differing significantly from the highest yielder at the 5 per cent. probability point.

The table is self explanatory and demonstrates, by inspection, the generally negative correlation between good tip coverage and yield. True flint grain is also hard to combine with high yield but if medium flint is combined with true flint it can be seen that this character is being fairly successfully allied to high yield.

A series of observations was carried out in 1961/62 in which four samples, each of about 2700 grammes, of each of nine leading varieties plus Local Unselected were prepared in the traditional way. Four women carried out the preparation each having one sample of all ten varieties. The Mphale flour plus germ percentages, representing the edible portion of the grain, are set out in Table III together with the mean yields of the varieties from Table II, both corrected, and uncorrected, for Mphale percentage.

TABLE II

Scores for Good Tip Coverage and Percentage Flint Grain for Leading Varieties Under trial at Chitedze

Variety	*Number of Trials from which Mean is taken*	*Mean Good Tip Coverage*	*Mean Percentage Flint and Medium/ Flint grain*	*Mean Yield of same Trials in lb. per acre*
Local Unselected	5	79	98	4,061
Namlenga	5	74	75	4,496
Local hybrid No. 2 F_1	4	81	96	4,227
,, ,, No. 7 F_1	5	59	83	5,289
,, ,, × GTC	3	87	94	4,271
,, ,, No. 10 F_1	4	47	69	5,173
,, ,, No. 11 F_1	4	50	78	5,650
,, ,, No. 12 F_1	4	65	88	5,001
Mlonda G.T.C.	3	65	93	4,290
Synthetic Variety No. 8 ..	4	48	75	5,058
,, ,, 15	5	55	91	4,639
,, ,, 16	5	39	77	4,769
,, ,, 17	5	61	88	4,831
,, ,, 21	5	66	86	4,824
,, ,, 22	5	40	84	4,757
,, ,, 23	3	61	100	4,201
,, ,, 27	3	57	98	5,206
,, ,, 28	3	44	78	4,458
,, ,, 29	5	55	82	5,116
,, ,, 30	4	35	84	5,531
,, ,, 31	5	58	89	4,999
,, ,, 32	5	46	92	4,962
,, ,, 38	3	61	79	4,978
,, ,, 40	3	61	94	4,772

TABLE III

Grain Yields and Mphale Percentage of ten Varieties

Variety	*Grain Type*	*Yield in lb./ acre*	*Grain Yield Order*	*Mphale %*	*Corrected Yield*	*Mphale Yield Order*
Local Unselected ..	Flint	4,061	10	78.6	3,192	9
Mthenga LH No. 7 ..	Medium	5,289	2	72.5	3,835	2
LH No. 10	Medium/Dent	5,173	3	71.5	3,699	5
LH No. 11	Medium/Dent	5,650	1	70.1	3,961	1
LH No. 12	Medium	5,001	6	74.2	3,711	4
SV. No. 8	Dent	5,058	5	67.4	3,409	8
Asikari SV. No. 17 ..	Medium	4,831	7	71.3	3,445	7
SV. No. 21	Medium	4,824	8	72.9	3,517	6
SV. No 29	Medium/Dent	5,116	4	74.0	3,786	3
Namlenga (O.P.) ..	Medium/Dent	4,496	9	69.7	3,134	10

In seven out of the ten varieties the yield order is changed when considering the usable material as opposed to the gross grain yields. Further changes occur if the white flour percentage alone is used as the yardstick of performance.

5. HYBRID YIELD TRIALS

1960/61:

A yield trial consisting of 16 new single crosses was run at Chitedze in the usual six replicate randomized block design. Each plot consisted of one row, five yards

long, and four standard crosses, as used in double hybrids were included as controls. The coefficient of variation was 11.7%, mean yield in lb. per acre being 8579. Least significant difference at the five per cent. level was 607 lb. and at the one per cent. level 828 lb.

The new crosses involved the Mexican 'T' lines numbers 2–9, each crossed individually with the established inbred lines R5115 and R5125. No cross significantly outyielded single cross 93 which was one of the controls, but the cross R5125 × T6 outyielded it slightly and was considerably better in tip coverage and flintiness of grain. Two further crosses, both in the same yield range as single cross 93, were considerably superior in tip coverage and grain character respectively.

1961/62:

A yield trial consisting of 59 treatments and three controls was laid down at Chitedze using a similar design and plot size as the previous year. The coefficient of variation was 15.7% and the mean yield in lb. per acre 8,250. Least significant difference at the five per cent. level was 717 lb. per acre, and at the one per cent. level 943 lb. per acre.

The basis of the trial was the series of crosses made at Chitala in the 1961 dry season, with the object of finding a replacement for SC 110 for combination with single cross 93 or vice versa.

Nine double cross hybrids significantly outyielded local hybrid No. 7, used as one of the controls, one only of these was better in both tip coverage and grain character. Although many crosses were better than local hybrid 7 in tip coverage and equivalent in yield, the majority were inferior in grain character, tending towards the dent grain type.

6. DISTRICT MAIZE TRIALS 1960/61

Single replications of five varieties were grown by a number of better farmers this year as they had been in the previous three years. Seven such observations were successfully conducted in the Southern Province, eight in the Central Province and eight in the Northern Province. Plots size was 1/40th acre and the yields are given in Table IV.

TABLE IV

District Maize Variety Observations

Mean Yield in lb. grain/acre

Province and Site notes	*Number of trials*	*Namlenga*	*Mthenga LH No. 7*	*Mlonda*	*Asikari*	*Grower's own seed*
SOUTHERN						
Low or Medium Altitude ..	6	1,427	1,763	1,425	1,531	1,418
Low Altitude (Lower River)	1	2,012	1,476	1,116	1,064	1,624
CENTRAL						
High Altitude	6	2,215	2,804	2,494	2,469	2,412
Low Altitude (Lake-Shore)	2	2,420	2,940	2,910	2,290	1,980
NORTHERN						
Medium Altitude (Mzimba District)	5	3,000	3,331	2,545	2,872	2,078
Medium Altitude (2 Rumpi, 1 Chisenga)	3	4,502	5,014	4,030	4,054	3,684

In the six low or medium altitude Southern Province trials Mthenga was the top yielder on three occasions, growers' own seed twice and Mlonda once.

In the six high altitude Central Province trials Mthenga was highest or joint highest yielder five times and Asikari highest or joint highest twice but differences between all varieties were small.

In the two Central Province Lake-Shore trials Mthenga was highest yielder on one and Mlonda on the other.

In the five Northern Province Mzimba District trials Mthenga was highest yielder on four occasions whilst Asikari was top once and second three times.

In the other three Northern Province trials Mthenga was highest yielder twice and Namlenga once.

The overall placing of Mthenga is extremely good but the actual differences between its yield and those of the growers' local maize are best on the medium altitude sites of Northern Province, where Asikari also did well. The Central Province Lake-shore sites also showed a big difference between Mthenga and local seed.

7. DISEASE INCIDENCE

As in previous years spraying trials were run in 1960/61 and 1961/62 to assess disease incidence. The design was in each case a randomized block of six variety treatments with plots split for Zineb spraying and no spraying. Differences between sprayed and unsprayed plots were significant in 1960/61 with high scores for both *Puccinia sorghi* and *Helminthosporium turcicum*. Yield loss due to disease was unusually high being 18.9 per cent. In the following year there were no significant differences and yield loss was low at 5.6 per cent. A late attack of *Puccinia polysora* did not reduce yields.

Maize Variety Trial, Makanga

This trial was laid down to test the yielding ability and other characteristics of some seven Chitedze bred varieties. Local unselected, Mlonda and Namlenga varieties were also included in the trial which was of a randomized block design with six replications. Planted in mid December early growth was good but dry weather at and subsequent to tasseling reduced yields. Storm winds in mid March laid much of the crop. There was a widespread attack of common rust *Puccinia sorghi* all varieties being equally attacked.

Yields are given in Table IVA none of the introductions significantly outyielded Mlonda.

TABLE IVA

Maize Variety Trial, Makanga

Treatments	*Variety*	*Yield lb. dry grain/acre*
1	Local unselected	1,391
2	Mlonda	1,935
3	Namlenga	1,037
4	S V 24	1,210
5	S V 25	596
6	S V 27	2,056
7	S V 28	2,004
8	S V 31	1,711
9	S V 38	1,218
10	S V 40	1,149
L.S.D. 5%		492
,, 1%		657
C. of V.		79%

MAIZE AGRONOMY

Fertilizer Trials

1. GYPSUM AMMONIUM NITRATE TRIALS

The object of this experiment was to compare this new nitrogenous fertilizer with equivalent quantities of sulphate of ammonia and 10:9:0 mixture under a range of soil and climatic conditions. A randomized block experiment with eight treatments and four replications was laid out at four of the experiment stations, more or less representative of the Highveld Plateau, the South Rukuru Basin, the Salima Lake-shore area and the Dolomite Plain. The results are tabulated in Table V.

TABLE V

Comparative Efficiency of Sulphate of Ammonia, Gypsum Ammonium Nitrate and 10:9:0 Mixture

Yield lb./acre grain

	Chitedze	*Mbawa*	*Chitala*	*Tuchila*
Soil series	Lilongwe	Loudon	Chitala	
Texture	S.C		S.C.L.	
pH	5.8		5.5	
Total N%	.160		.087	
Available P p.p.m.	7		2	
K m.e.%	.41		.37	
Nil	6,330	2,190	670	2,320
100 lb./acre S/A (21 lb. N)	6,120	3,600	1,270	2,850
200 lb./acre S/A (42 lb. N)	6,230	4,070	1,440	2,970
100 lb./acre G.A.N. (21.4 lb. N)	6,180	3,050	1,230	2,520
200 lb./acre G.A.N. (42.8 lb. N)	6,110	3,960	1,910	2,750
200 lb. S/A and 200 lb. single superphosphate (42 lb. N + 36 lb. P_2O_5)	6,610	4,560	1,050	3,140
400 lb./acre 10:9:0 before planting ..	6,670	4,180	1,660	2,430
400 lb./acre 10:9:0 top-dressed	6,790*	3,670	1,940	2,730
L.S.D. 5%	360	630	500	660
Mean	6,380	3,660	1,400	2,710
Coef. of Variation	3.8%	11.6%	20.5%	16.4%

Superphosphate was applied in a band in the ridge before planting, the straight nitrogenous fertilizers were top dressed in dollops beside each hill within a month of planting, and the 10:9:0 mixture was applied in both ways. Under these conditions the gypsum ammonium nitrate appeared to be not quite as effective as sulphate of ammonia, but there is not a great deal of difference, and the former fertilizer would be preferable on acid soils and where an immediately available dose of nitrogen is required. 10:9:0 mixture is probably best applied as a top dressing as soon as possible after germination, and is then as good as equivalent single superphosphate applied before planting and sulphate of ammonia top dressed within a month of germination.

2. MAIZE/TOBACCO CORRELATION TRIAL

In the experiment described in section 6, three of the pairs of replicates were planted one to maize and one to tobacco, in order to confirm past findings that maize fertilizer trials will show whether or not tobacco will respond to fertilizers under similar conditions, but will not enable an estimate of the size of the response to be made. The figures given below do indicate that this is so, though the effect of phosphate on tobacco quality in this experiment is unexpected.

TABLE VI

Responses to Nitrogen and Phosphate given by Maize and Tobacco on Adjacent Plots

Treatment	Western Tobacco		Mthenga Maize
	Yield/acre lb. cured leaf	Mean Grade Index	Yield/acre lb. grain
N_0—Nil	760	27.17	4,920
N_1—100 lb./acre S/A.	890	22.68	5,060
N_2—200 lb./acre S/A.	960	25.67	5,420
P_0—Nil	760	27.54	4,660
P_1—200 lb./acre single supers	940	25 01	5,110
P_2—400 lb./acre single supers	920	22.98	5,630

3. RESIDUAL FERTILIZER TRIALS

There were no significant residual effects obtained in the following trials:—

(*a*) A maize test crop at Chitedze grown on Mwanjema soil series after maize fertilized in 1959/60 with 200 lb./acre sulphate of ammonia, 200 lb./acre single superphosphate and 5 tons/acre farmyard manure in a factorial design (the positive response to the nitrogen of 1½ bags was significant). Mean was 3,360 lb./acre grain and the coefficient of variation 11.2%. In the first year there were responses of 6½ bags/acre maize to the nitrogen treatment, 1½ bags/acre maize to the phosphate treatment and 2½ bags/acre maize to the manure.

(*b*) A second maize test crop at Chitedze grown on phosphate deficient Mwanjema soil series after maize fertilized in 1959/60 with 200 and 400 lb./acre sulphate of ammonia and 400 lb. single superphosphate in a 3×2 factorial design. There had been a significant response to superphosphate in the first test crop. Mean 3,640 lb./acre grain. Coefficient of variation 9.9%.

(*c*) A maize test crop at Chitala grown on Chitala series soil after a cotton crop fertilized in 1960/61 with 200 and 400 lb./acre sulphate of ammonia in randomized block design. Mean 2,520 lb./acre grain. Coefficient of variation 16.0 per cent.

There were residual effects recorded in two experiments on phosphate deficient Lilongwe series soil where a maize test crop was grown after fertilized tobacco.

(*a*) In the first a 3×3×3 factorial with one replicate, there were no residual responses to 150 and 300 lb./acre sulphate of ammonia applied to tobacco in 1960/61, nor to 60 and 120 lb./acre sulphate of potash applied to the same tobacco crop. 500 lb./acre single superphosphate did however give a significant residual response of 1¾ bags of grain. Mean 4,320 lb./acre grain. Coefficient of variation 5.9 per cent.

(*b*) In the second a 3×3 factorial with three replicates, there was no residual response to 100 and 200 lb./acre sulphate of ammonia applied to tobacco in 1960/61, but there was a significant increase of 2½ bags/acre grain resulting from a 200 lb./acre application of single superphosphate in 1960/61. The 400 lb./acre level of supers gave no further increase. Mean 6,280 lb./acre grain. Coefficient of variation 3.4 per cent.

4. RESIDUAL TEST CROP AFTER MAKARIKARI FERTILIZER TRIAL AT MBAWA

In 1956 a 3×3×3 factorial, single replicate trial was laid out on a Makarikari ley at Mbawa to test the effects of nitrogen, phosphate and farmyard manure upon the

productivity of this grass species planted upon Loudon series soil. In early 1961 the ley was ploughed up and a test crop of maize, without fertilizer, was grown on the site. The experiment was rather inaccurate, but shows a marked residual response to phosphate application on this phosphate deficient site.

TABLE VII

Responses by Maize to residual effects of Fertilizer Treatments applied to a Makarikari Ley

Variety: Asikari *Soil series: Loudon* *Yield: lb./acre grain*

Treatments applied annually during years 1956/57–1960/61	*Soil Analysis October, 1961*				*Yield*
	pH	*N*	*P*	*K*	
N_0—Nil	5.6	.082	48	.67	3,030
N_1—300 lb./acre S/A	5.2	.076	50	.57	2,850
N_2—600 lb./acre S/A	5.0	.088	73	.70	2,990
P_0—Nil	5.3	.083	36	.70	2,310
P_1—300 lb /acre single supers and Raw Rock P.	5.2	.074	59	.53	2,930
P_2—600 lb /acre single supers and Raw Rock P.	5.3	.087	87	.67	3,630*
D_0—Nil	5.1	.068	54	.48	3,080
D_1—5 tons F.Y.M.	5.3	.084	42	.67	2,700
D_2—10 tons F.Y.M.	5.5	.102	66	.88	3,090

Coefficient of Variation 26.2% L.S.D. 5% 900 Mean 2,960

5. DISTRICT OBSERVATION PLOTS

Partly to train field staff in plot technique and partly as further investigation into nutrient limitations and the value of farmyard manure in district gardens, a series of single replicate plots was laid out in a factorial design, with three varieties and three to six fertilizer treatments, depending upon the district. 76 results were obtained in Central Province and 45 were obtained in Southern Province. Nitrogen was nearly everywhere the nutrient in greatest demand, while phosphate responses, where found, usually occurred on over-cultivated red ferruginous soils of potentially high productivity. The organic manure gave very variable and usually disappointing results in the year of application, unless fertilizer nitrogen was applied with it. Below are listed by districts the number of observation plots giving a response to 5 tons/acre of organic manure of 2 bags grain per acre or more, together with the total number of observations in which organic manure (farmyard or open khola) was included.

District	*Number of sites giving at least 2 bags/acre response*	*Number of sites at which organic manure was applied*
Lilongwe	9 (50%)	18
Dowa	6 (50%)	12
Salima	2 (50%)	4
Fort Manning	3 (37.5%)	8
Kasungu	2 (40%)	5
Kota Kota Hills	5 (83.3%)	6
Dedza Hills	3 (33.3%)	9
Ncheu	4 (44.4%)	9
Kasupe	0 (Nil)	2
Blantyre	1 (50%)	2
Cholo	1 (33.3%)	3

It is evident that there is something wrong either with the quality of the manure or with the time or method of application. As in nearly every case the plots giving the highest yields at each site were those dressed with organic manure plus sulphate of ammonia, it is probably the quality that is to blame. This is borne out by the fact that of the 36 trials giving some response to organic manure, only 15 showed 5 tons of 'F.Y.M.' to give a greater yield than 200 lb. of sulphate of ammonia. Thus though 'F.Y.M.' almost certainly acts as an insurance policy, a reservoir of plant foods to be released slowly, it is by no means safe to assume, at the present time, that if a farmer applies manure alone to his maize crop he will automatically get an increase in yield. Manure plus fertilizer should be the recommendation unless the manure to be used has been analysed and shown to have a high content of available nitrogen. A survey of the nutrient status of village samples of 'F.Y.M.' is now being undertaken.

Results of district trial plots will be summarized by soil series in the Bulletins that are at present being prepared on the Agro-ecological zoning and Agricultural Potential of the three Provinces.

6. FERTILIZER TRIALS AFTER RHODES GRASS CARRYING CAPACITY TRIAL

During the period 1957/58 to 1959/60 one of the main rotation fields at Chitedze was divided into paddocks for a Rhodes grass carrying capacity trial which has been described in the Grassland Section of the reports for 1958/59 and 1959/60. Adjoining the trial was one control area cut for hay each year. In December, 1960, the complete experiment and control were given 200 lb. sulphate of ammonia to the acre. Silage was cut in February, 1961, and the ley ploughed out in March.

The grazing treatments had been (A) Rhodes grass unfertilized, with hay and silage saved for the dry season and fed on the plots, (B) similar management but with 400 lb. of sulphate of ammonia top dressed per year, (C) Rhodes grass to be used *in situ* giving rains grazing and dry season foggage. The (C) treatment was originally established with pigeon pea (*Cajanus cajan*) planted in double rows 6 feet apart but this virtually disappeared during the first grazing year and could not be re-established.

On being ploughed out each of the nine paddocks had two replicates of a 3×3 NP trial laid out on it, while the control area had four such replicates. There were large responses to both the nitrogen and phosphate, the latter being particularly heavily depleted in the soil as a result of past cropping. The soil was sampled in October, 1961.

TABLE VIII

Effect of Fertilizer on Maize grown after a four year Rhodes Grass ley variously managed

Variety: Mthenga *Soil series: Lilongwe* *Yield: lb./acre grain*

	A	B	C	O
Herbage	Rhodes grass grazed and cut.	Fertilized Rhodes grass grazed and cut.	Rhodes and (Pigeon Pea) grazed.	Rhodes grass cut.
Live weight gain lb./acre/annum ..	48.1	86.7	37.7	hay
Mean yield of Maize test crop 1961/62	5,130	4,660	5,030	5,130

L.S.D. 5% .. .. .. 230 (A v. B v. C) Coef. Varn. 11.0%
340 (O v. ABC)

TABLE VIII—(*Continued*)

Soil Analyses	A		B		C		O	
	1958	1962	1958	1962	1958	1962	1958	1962
pH	6.2	5.7	5.9	5.6	6.0	5.7		5.6
Organic Carbon% ..	2.42	1.99	2.07	2.00	2.17	1.88	Not	2.04
Total N%	0.178	0.151	0.178	0.162	0.180	0.154	sampled	0.159
Available P p.p.m.	9	3	5	4	5	3		3
K m.e.%	0.24	0.36	0.30	0.43	0.27	0.51		0.32

Two-way Tables		P_0 Nil	P_1 200 lb. Supers	P_2 400 lb. Supers	Mean
Treatment A	N_0—Nil	4,070	4,860	4,890	4,610
L.S.D. 5% Margins 400..	N_1—100 S/A	4,350	5,480	5,830	5,220
Centre table 690..	N_2—200 S/A	4,680	5,780	6,220	5,560
	Mean	4,370	5,370	5,650	5,130
Treatment B	N_0—Nil	4,160	4,560	4,540	4,220
L.S.D. 5% Margins 400..	N_1—100 S/A	4,310	4,560	5,140	4,670
Centre table 690..	N_2—200 S/A	4,020	5,260	5,360	4,880
	Mean	4,160	4,790	5,010	4,660
Treatment C	N_0—Nil	4,120	4,860	5,140	4,710
L.S.D. 5% Margins 400..	N_1—100 S/A	4,000	5,080	5,470	4,850
Centre table 690..	N_2—200 S/A	4,330	5,800	6,430	5,520
	Mean	4,150	5,250	5,680	5,030
Treatment O	N_0—Nil	4,070	5,010	5,550	4,880
L.S.D. 5% Margins 440..	N_1—100 S/A	4,490	5,520	5,830	5,280
Centre table 770..	N_2—200 S/A	4,330	5,550	5,830	5,240
	Mean	4,300	5,360	5,740	5,130

The overall NP interaction was significant and showed that there was little response to nitrogen unless phosphate was also applied. No interactions between fertilizer and ley management were significant, but it does appear that in treatment B the responses to fertilizer were less than in the other treatments. All yields were high and there appears to have been little difference between the effects of grazing and cutting.

The main points to be learned from this experiment are:

(1) That in these potentially very fertile soils, phosphate will become limiting after some six to eight years of intensive cropping including grazed leys and using nitrogenous fertilizers only.

(2) That a ley, if it is utilized at all, will not remedy this position.

(3) That this Lilongwe soil series is generally remarkably well buffered, and that provided adequate steps are taken to replace losses of organic matter and plant foods resulting from the removal of heavy crops, it does not matter particularly how this is done.

Cultivation Trials

1. MAIZE POPULATION TRIALS

At Chitedze, simple randomized block experiments were laid out on a high fertility site and on a low fertility site on Lilongwe series soil, to see how the number of barren plants, cob size and yield would be affected by populations lower than normal on potentially fertile but over-cropped soil. In neither case was it worth decreasing the population in a hill stand spaced at 3 ft. by 3 ft.

TABLE IX

Effect on Maize Crops of Reducing the Number of Plants Per Hill

Treatment	*Yield/ acre lb. grain*	*Plants/ acre*	*Cobs/ acre*	*Barren Plants/ acre*	*lb./ cob*
A. Low fertility (Namlenga)					
3×3×1 plant	1,690	4,810	4,600	210	.538
3×3×2 plants	2,370	9,440	8,140	1,300	.428
3×3×3 plants	2,620	13,760	11,070	2,690	.347
L.S.D. 5%	250				
Mean	2,230	Coefficient of variation 14.8%			
B. High fertility (Mthenga)					
3×3×1 plant	3,070	4,840	6,200	Nil	.698
3×3×2 plants	5,520	9,680	11,000	Nil	.707
3×3×3 plants	7,090	14,400	14,560	Nil	.687
L.S.D. 5%	390				
Mean	5,230	Coefficient of variation 7.0%			

2. MAIZE SPACING AND FERTILIZER TRIAL

At Chitedze, on a fertile but slightly phosphate deficient soil of the Lilongwe series a 3×2 factorial trial was laid out to test the relative advantages of a hill or a single plant stand of maize at a population of 14,500 plants per acre under different levels of fertilizer application. Even the control plot was relatively fertile. The results indicate that single plant stands make better use of applied fertilizer, but that on unfertilized soil in good heart there is little to choose between the two spacings provided that the stand is good.

TABLE X

Effect of spacing on Maize grown at differing levels of Fertilizer Application

Variety: Mthenga *Soil series: Lilongwe* *Yield: lb./acre grain*

	Yield		*Mean*	*Plants/ acre*	*Barren Plants/ acre*	*lb./ cob*
	3×3×3 plants	*3×1×1 plant*				
No fertilizer applied	5,140	4,900	5,020	14,520	820	0.526
200 lb./acre 25:10:0	4,790	5,530	5,160	14,490	880	0.544
400 lb./acre 25:10:0	5,470	5,900	5,690*	14,490	670	0.590
Mean	5,130	5,440*	5,290	—	—	—
Plants/acre	14,500	14,500	—	L.S.D. 5% spacing=250		
Barren Plants/acre	930	640	—	L.S.D. 5% fertlizer=310		
lb./cob	0.543	0.564	—	Coef. of var. =5.5%		

3. MAIZE LOSS OF PLANT TRIAL

The object of this trial was to find out to what extent maize would compensate for the loss of plants or hills. To this end a randomized block experiment with 12 treatments and four replicates was laid down on fertile Lilongwe series soil, and plots were thinned to give a series of missing hill treatments at a number of different populations. Each plot was a 12 yd. row sandwiched between guard rows of $3 \times 3 \times 3$ plant spacing. In hill stands, six seeds were planted in each hill. In those treatments where four out of the twelve hills were removed, the plant population was maintained by leaving four or five plants in each of the remaining hills.

TABLE XI

Effect of Loss of Plants and/or Hills on Maize Yields

Variety: Mthenga *Soil series: Lilongwe* *Yields: lb./acre grain*

Treatment (*Maximum of* 36 *plants and* 12 *hills per plot*)	*Yield/ acre*	†*Plants/ acre*	*Barren plants/ acre*	*lb./ cob*
1. 3′×3′×3 plants—no missing hills	5,760	14,280	320	0.584
2. 3′×3′×4 or 5 plants—4 single hills missing ..	5,070*	13,710	640	0.550
3. 3′×3′×4 or 5 plants—2 pairs of hills missing	5,460	14,120	160	0.554
4. 3′×3′×4 or 5 plants—4 hills in a row missing	5,060*	14,440	650	0.520
5. 3′×3′×2 plants—no missing hills	4,480*	9,520	Nil	0.656
6. 3′×3′×3 or 4 plants—4 single hills missing ..	4,600*	9,680	Nil	0.662
7. 3′×3′×3 or 4 plants—2 pairs of hills missing	4,000*	9,680	580	0.621
8. 3′×3′×3 or 4 plants—4 hills in a row missing	4,240*	9,600	Nil	0.625
9. 3′×1′×1 plant—full stand	5,940	13,960	170	0.610
10. 3′×1′×1 plant—4 plants missing	5,760	12,910	Nil	0.632
11. 3′×1′×1 plant—8 plants missing	5,510	11,290	Nil	0.641
12. 3′×1′×1 plant—12 plants missing	5,260*	9,680	Nil	0.689
L.S.D. 5%	630			
Mean	5,100	Coef. Varn. = 10.2%		

† at harvest.

Maize will compensate to a fair degree for variations in population by increasing or decreasing the number of barren plants or the size of individual cobs. In a single plant stand there is a steadily increasing loss in yield for every 10 per cent. loss of plant, but these losses are relatively insignificant provided that the harvested stand is not less than 80 per cent. of the theoretical population intended. Missing hills in a hill stand can markedly reduce yields, especially if they occur adjacently, even though the number of plants per hill is increased to make up the desired total. If there is no compensating increase in the number of plants per hill, missing hills will give even greater reductions in yield. Thus it is important that missing hills should be ' supplied ' even in a field crop, and if there is more than a 20 per cent. loss of plants or hills in experimental plots, care must be taken in interpreting the results if these losses are not an inevitable result of the treatment applied. A basal dressing of 200 lb./acre sulphate of ammonia and 200 lb./acre single superphosphate was applied to these plots, and under these conditions the single plant spacing gave a noticeably higher yield than the hill planting especially at the lower plant population.

4. TIME AND METHOD OF PLANTING

This was an observation at Chitedze on Lilongwe series soil, in which maize was planted at a number of different dates at the beginning of the rains, chosen for their differing soil moisture regimes. At each date three methods of planting were used

and there were four replicates of each treatment. The treatments were not completely randomized and the plots were very small 1 row × 10 yds. only. Eight times of planting were accomplished between 17th November and 12th December. All later plantings were destroyed by mice.

TABLE XII

Effects of time and method of Planting on Maize Yields

Variety: Mthenga *Soil series: Lilongwe* *Yields: lb./acre grain*

Treatment	*Yield*	*Plants/ acre*	*Cobs/ acre*	*lb./ cob*
Planted with stick 2" (deep)	6,810	12,320	13,160	0.710
Planted with stick 1" shallow)	4,580	9,060	9,480	0.663
Planted with hoe	6,330	11,780	12,470	0.696

Time of planting	*Deep planted*		*Hoe planted*		*Shallow planted*	
	Yield	*Plant No. per acre*	*Yield*	*Plant No. per acre*	*Yield*	*Plant No. per acre*
17/11 Dry just before rain ..	5,500	11,250	6,040	11,250	4,700	9,320
18/11 On first rain ..	7,220	13,430	6,360	12,700	5,130	9,920
24/11 Drying	6,920	12,830	6,780	12,580	5,750	11,130
28/11 Drying	7,800	12,700	6,200	10,890	3,220	7,020
2/12 Moist before 5 dry days	7,420	12,580	6,040	11,130	2,520	3,990
6/12 Dry before rain ..	7,440	13,430	6,660	12,580	4,910	10,040
9/12 Just before rain ..	6,460	11,490	6,330	11,980	5,980	12,460
13/12 Wet	5,690	11,010	6,200	11,250	4,440	8,710

Three seeds were planted per hill at a 3 ft. × 3 ft. spacing, and were not supplied. In the stick planting the seeds tended to be on top of one another. This does not appear to matter provided the seed is planted about 2 inches deep and does not need to be thinned. Shallow planted seed is much more liable to desiccation, to attack by birds and mice, and does not seem to produce such deep rooted vigorous plants. Both this year's and last year's results point to the fact that untimely planting in relation to the early rainstorms can cause losses of yield potential even though the date is early. The best time for planting is within 48 hours of storms of about 0.5 inches.

From previous experience it appears that dry planting too early is likely to lead to excessive loss of seed before germination through the depredations of mice, birds and termites. Delaying planting for more than a fortnight after the onset of the rains is however more risky than dry planting.

OTHER CEREALS

Sorghum

1. VARIETY TRIAL, CHITEDZE

The more promising of the sorghum varieties kept at Chitedze were tested this year against the red K_2 sorghum which is favoured by the brewing trade. A randomized block design was used with 15 treatments and six replicates, the plot size being 1 row × 20 yds. i.e. 20 sq. yds. Chitedze is not in an area which normally grows sorghums, and the seed was dressed with Agrosan which turned out to be contrary to the makers advice. Germination was very poor, requiring several rounds of supplying and as a result the stand was very uneven. Bird damage was severe particularly on the early varieties, the red K_2 variety being virtually wiped out. The proportion of seed to stalk (by weight) given in the third column of figures in Table I gives some indication of the damage sustained by each variety.

TABLE I

Yields of Sorghum Varieties at Chitedze (Lilongwe series soil)

Variety	*Yield/ acre lb. seed*	*No. of heads harvested/ acre*	*Seed Wt. Dry stalk*
US/16	1,350	12,140	5.30
TS/6	1,060	12,950	3.33
TS/14	1,050	11,450	3.72
SS/40	1,040	12,060	3.64
NS/5	980	10,730	2.81
US/2	890	6,130	4.08
SS/25	830	15,120	3.80
NRS/6	730	11,610	3.85
NS/9	710	9,520	2.80
US/12	670	10,080	2.75
TS/26	640	8,910	3.09
SS/28	490	4,070	4.96
NS/2	360	5,850	2.21
NS/10	230	5,080	2.30
RED K_2	20	8,930	0.23
L.S.D. 5%	270	Coefficient of variation 31.7%	

2. RESIDUAL FERTILIZER TRIAL, CHITALA

Sorghum planted without fertilizer on the site of a cotton N.P.K. and spacing trial grown in 1960/61 season on Chitala series soil, showed no residual responses to any of the fertilizer treatments. These were 200 lb./acre sulphate of ammonia, 200 b./acre single superphosphate and 50 lb./acre muriate of potash in all combinations land applied in December, 1960. There were no responses in the cotton crop, though soil nitrogen levels were low on analysis. Mean yield of sorghum 1,220 lb./acre grain. Coefficient of variation 16.1 per cent.

3. DISTRICT TRIALS

Single replicate observation trials were conducted at three sites in Fort Johnston District and four sites in the Lower River. They were composed of six or eight plots on a 3×2 or 4×2 factorial design—two or three local varieties compared with Red K_2 sorghum in the presence and absence of 200 lb. acre sulphate of ammonia.

In Fort Johnston the best variety all round was Kaswakanda, a long-term, white-seeded, goosenecked variety, showing some resistance to bird damage. This produced yields of grain ranging from 1,000–2,000 lb./acre. The Red K_2 was badly attacked by birds and gave rather disappointing results. Responses to sulphate of ammonia were very variable, though soil nitrogen was at all sites low, and it is thought that the response is probably inversely proportional to the degree of bird damage, though records were inadequate to prove this.

In the Lower River the Red K_2 was again disappointing, and bird damage evidently considerable. Yields were very variable from place to place. In Port Herald District the best variety, Gwandachisero, gave about 2,200 lb./acre grain on sandy soil, and a shelling percentage of some 60 per cent. In Chikwawa District the best variety, Phutyu, gave about 3,000 lb./acre on black cotton soil, and a shelling percentage of some 65 per cent. There may be responses to nitrogen of some 400 lb. grain per 200 lb. sulphate of ammonia on the sandier soils, but not on the heavy ones. Application of nitrogen did not improve the shelling percentage—this may be due to bird damage.

Bulrush Millet

District observation plots in the Lower River area showed that the improved Nigerian seed gave considerably better yields than the local seed, and that there were responses to nitrogen of the order of 400 to 600 lb./acre grain for a dressing of 200 lb./acre sulphate of ammonia. The best yields at each site ranged from 1,000–2,000 lb./acre seed. Shelling percentage which varied widely from site to site averaged about 50 per cent. and were if anything slightly increased by application of nitrogen.

A bulking plot of Hedgehog Bulrush Millet grown at Chitedze was again badly attacked by Downey Mildew (*Sclerospora graminicola*) though as far as it is known the crop had never been grown on the site before, and it was well isolated amongst sorghum and sunflower plots. The seed was not treated in any way, but came from a crop which had itself been attacked. Only 130 lb./acre seed was harvested.

Rice

District observation plots on the Kota Kota Lake-shore showed that there should be large responses to 200 lb./acre sulphate of ammonia on gardens where unfertilized yields are of the order of 1 ton/acre or less. Increases recorded ranged from 800 to 1,200 lb./acre paddy—control yields ranged from 2,450 to 550 lb./acre paddy. One garden with a control yield of 3,500 lb./acre paddy gave no response.

Barley

1. VARIETY TRIALS

A number of malting barley varieties, both 2 row and 6 row were tried out in the winter of 1962 in the Kirk Range areas of Blantyre and Ncheu Districts. Planting took place from the middle of April to the middle of May, and the crop was harvested in September/October.

Of the 2 and 6 row varieties obtained from Messrs. Heinrichs, the latter gave by far the better yields, when tested in variety and cultivation trials described in section 2.

TABLE II

Yields of Barley Varieties in Lb./Acre Seed

Variety	*Mposadala Blantyre*	*V.H. Gochi Ncheu*	*Alifonso, Gochi II Ncheu*
2 row	932	843	816
6 row	1,516	1,273***	1,436***
L.S.D. 5%	352	95	216
Planted	15/4–16/5	26/4–21/5	17/4–17/5
Harvested	21/9–25/9	3/10–6/10	5/10–16/10
Notes	Altitude 4,800 ft. Shelling % 80	Red S.C. soil Rains ended mid May Dry season 1.7"	Red S.C. soil Rains ended mid May Dry season 0.7"

The variety Californian Atlas was tested in observation plots at Mposadala, Masamba and Dambe in Blantyre. The crop gave less than 500 lb./acre at the two latter sites but at Mposadala gave about 2,500 lb./acre seed. Sulphate of ammonia had little effect.

The varieties received from S. Rhodesia and planted in duplicate plots in Ncheu District, gave the following yields and statistics.

Variety	*Days to Maturity*	*Yield*	*Notes*
Californian Atlas	88 ..	3,550	6 row, short and prostrate
B. 20	62 ..	2,620	2 row
B. 35	88 ..	2,380	6 row, short and prostrate
B. 23	62 ..	2,310	2 row
S_1. A_1 A_3	62 ..	1,970	2 row
B. 14	62 ..	1,710	2 row, purplish
B. 33	88 ..	1,680	6 row, short and prostrate

At Mwera Hill much damage was done by birds and mice and the varieties tested there yielded as follows:—

S.29=530 lb./acre; S.76=300 lb./acre; H.7 and F.20 less than 150 lb./acre.

2. CULTIVATION TRIALS AND TIMES OF PLANTING

These trials were 2×2 ($\times 2$) factorials with three blocks planted at three different times. The trial in Blantyre had two replicates and no fertilizer treatment, while those in Ncheu had presence and absence of N included, but only one replicate per site. The treatments were:

6 row vs. 2 row variety (mentioned above).
Traditional spot planting vs. Drills.
Nil vs. 200 lb./acre S/A (Ncheu only).

The tradition is to clean hoe the garden after the last rainstorm of the wet season and then to plant clumps of 8–9 seeds in holes made with a small hoe some 8 in. apart. The depth of sowing is $\frac{1}{2}$ inch–$1\frac{1}{2}$ inches and the seed-rate approximately 70 lb./acre.

After planting there may be one weeding or none at all. If planting is done too early there is a danger that the final rainstorms will fall on the newly hoed fields, which are on very steep slopes, and wash away both soil and seed. This happened at Alifonso. Drilling offers little improvement unless there is a machine to do the work, when a higher seed-rate would enable a closer stand to be planted much more rapidly. Yields are as often as not limited by plant population, which suffers first from the tedious process of planting and then from the depredations of birds and mice. Harvesting is done by hand, not with a reaping hook, but by cutting off individual heads with a knife. This is tedious but enables a much smaller load to be taken back to the village, for threshing. Slopes are usually too steep for ox carts to operate and transport is by head load.

TABLE III

Results of Cultivation Trials in Lb./acre Seed

Treatments	*Mposadala*	*V.H. Gochi*	*Alifonso, Gochi*
Spot planting	1,275	1,020	1,205
Drill	1,170	1,095	1,050
Nil	—	1,065	1,050
200 lb./acre S/A	—	1,050	1,200
L.S.D. 5%	350	95	215
T_1 (date)	735 (15/4)	1,140 (26/4)	765 (17/4)
T_2 (date)	1,375 (1/5)	1,040 (9/5)	1,355 (3/5)
T_3 (date)	1,560 (16/5)	990 (21/5)	1,255 (17/5)
L.S.D. 5%	430	115	265
Mean	1,225	1,060	1,125
Coef. Varn.	32.0%	10.2%	21.9%

3. FERTILIZER TRIALS

A series of single replicate 2^4 factorial trials, confounded to give two blocks of eight plots at each site, was conducted in the Kirk Range area of Ncheu and Blantyre. They were exploratory trials testing the presence and absence of 200 lb./acre sulphate of ammonia, 120 lb./acre of double superphosphate (38% P_2O_5), 100 lb./acre of muriate of potash and 5 tons acre of farmyard manure. The soils were mostly acid sandy clays or sandy clay loams, high in nitrogen but low in phosphate.

There is little requirement for artificial fertilizer, and one is more likely to reduce yields by applying unbalanced nutrients than to increase them. There are usually no responses to sulphate of ammonia of any size, though the main response at Gochi, and the interaction at Chabonga and Dzinjiliza indicate that 200 lb./acre of sulphate of ammonia, if it does not scorch the plants of 200–300 lb./acre seed. In spite of the low level of available phosphate, the responses to single superphosphate were negligible, the interactions indicating that the best yields come from no fertilizer or the single nutrient. It is possible that the added phosphate is fixed in the rather acid soil. Potash did more harm than good, and in interactions with other elements always reduced any response there may have been to the other elements. The value of farmyard manure as an ameliorative and restorative is very evident. Except at Dambe there were significant increases of the order of 300–600 lb./acre seed. There was a significant N.P.D. interaction at three sites and they all show the same sort of pattern.

TABLE IV

Results of Fertilizer Trials on Barley in the Kirk Range

Variety: 2 row or 6 row ex Heinrichs. Yields: lb./acre seed

Treatment	*Badwell Gochi V.*	*Mbingwani Kabwata V.*	*Vereson Chabonga V.*	*Harrison Dzinjiliza V.*	*Masamba*	*Dambe*
Altitude ..	<————	————4,000	to 5,000 ft.	————>	c.5,000 ft.	3,950 ft.
Soil Texture ..	S.C.	S.C.L.	S.C.L.	S.C.L.		S.C.L.
pH	5.5	6.0	5.7	6.0		5.0
%C.	2.28	2.24	2.65	2.04		1.2
Avail. P. p.p.m.. .	3	1	3	2	Not	4*
%N.	0.222	0.243	0.235	0.210	Sampled	0.10
K. m.e.% ..	0.26 (Approxi-mate)	0.37	0.35	0.32		0.40
O	1,920	1,820	1,580	1,870	820	440**
N	2,070*	1,970	1,570	2,020	800	310
O	1,940	1,860	1,510	2,080*	740	370
P	2,060	1,930	1,640	1,820	880*	370
O	2,090**	1,770	1,690	2,120**	810	340
K	1,910	2,020	1,460	1,770	810	400
O	1,920	1,730	1,250	1,670	650	370
D	2,080*	2,060*	1,890***	2,230***	970***	380
L.S.D. 5% ..	130	300	240	230	140	70
Significant Interactions ..	None	N.P.D.***	N.K.* P.K.* N.P.D.**	N.P.*** N.K.*	None	N.D.* N.P.D.***
Planting date ..	4/5/62	4/5/62	4/5/62	7/5/62	17/4/62	11/4/62
Harvesting ..	28/9/62	20–22/9/62	29/9–9/10/62	18/10/62	26/9/62	22/9/62
Variety planted	2 row	Mixture	2 row	6 row	6 row	6 row
Mean ..	2,000	1,900	1,570	1,950	810	370
Coef. Varn ..	5.8%	14.2%	12.5%	10.0%	15.0%	15.4%

* Phosphate determination done by 15 minute extraction and giving results 5–6 times greater than the others; done by a 1 minute extraction.

	Mbingwani		*Chabonga*		*Dambe*	
	D_0	D_1	D_0	D_1	D_0	D_1
N_0P_0	1,310	**2,230***	980	**1,950***	350	**470***
N_0P_1	**2,090**	1,640	**1,540**	1,860	**610***	330
N_1P_0	**2,090**	1,980	**1,520**	1,600	**320**	350
N_1P_1	1,430	**2,400***	990	**2,160***	190	**370***

In the absence of farmyard manure, *small* dressings of artificial nitrogenous and phosphatic fertilizer may give increases. The soil is however very acid and any large amount of fertilizer, especially if it is acid, will do harm. The limit is probably a total of 200 lb./acre. Farmyard manure gives big increases, but the benefit may well be lost if unbalanced acid fertilizer is applied with it. However, these conclusions need to be treated with caution, for in the contounding the groups of black figures have no K in Block I and K in Block II, while the other group is associated with K in Block I and no K in Block II. As in all cases block differences are large—this may be an expression of the depressing effect of muriate of potash. In future trials, K should be excluded and non acid fertilizers used.

Extract from Report of the Entomologist

RICE

The Hispid beetle (*Trichispa sericea* Guer.), recorded for the first time in Nyasaland in February, 1961 (Ann. Rept. 1960/61), has been found on only one occasion this season, and no damage has been reported.

OIL SEEDS

Groundnuts

1. YIELDS AND OIL CONTENTS OF IMPROVED VARIETIES

Variety trials of randomized block design were conducted at Chitala, Mbawa and Tuchila, and of lattice square design with 49 and 64 treatments and three replicates at Chitedze. Plot size was 1 ridge × 20 yards at the former sites and 1 ridge × 10 yards at the latter. These figures are extracted from the trials.

A heavy attack of " rosette " virus disease at Chitedze affected most severely the early bunch and the very prostrate runner types. Mani Pintar again leads the field by a substantial margin in yield and oil percentage, and it is unfortunate that buyers do not really like this variety. Mwitunde has been surpassed by a number of varieties this year and it is again evident that, except for Mani Pintar, there is no one variety that excels at all altitudes.

2. ROSETTE RESISTANT VARIETIES

A number of allegedly rosette resistant varieties were imported and planted in observation plots at Tuchila and Mbawa, and in one of the lattice squares at Chitedze. No comments on resistance were available from the first two stations as there was little " rosette ", but the yields in this initial year were low. At Chitedze, the varieties were not by any means all completely resistant, but yields were on a par with that of Mwitunde.

Five varieties said to show field resistance to Cercospora leaf spot were also imported for trial.

3. DISTRICT TRIALS

(*a*) *Northern Province*

In variety trials Mani Pintar gave the highest yields at all sites in the South Rukuru basin, followed by Chalimbana and Mwitunde. In Karonga Hills and Plateau areas, Dixie Runner did as well as Mani Pintar, and very much better than the short term Gambia variety.

(*b*) *Central Province*

In the Kasungu/Fort Manning area, there was little to choose between Mwitunde and Chalimbana, though both outyielded the local runner. While there appeared to be no response to gypsum or superphosphate in Kasungu, there were large increases resulting from applications of 200 lb./acre single superphosphate in Fort Manning. Yields were in places doubled, and as soil P was not markedly low, sulphur deficiency is suspected.

On the Dowa/Lilongwe Plateau, Mani Pintar outyielded Mwitunde in nearly every case, while Mwitunde outyielded the local runner. There were no marked yield increases as a result of applying single superphosphate.

In the Hills bordering the Escarpment there is less marked and regular difference between varieties, especially at the higher altitudes where conditions are borderline for groundnut production. Mani Pintar was nevertheless outstanding at many sites. There are responses to superphosphate on the leached red soils bordering on the ferrisol type, particularly in the Dedza/Biriwiri area.

On the Lake-shore plain Early Runner tended to outyield Mani Pintar on the alluvial soils, but the position tended to be reversed as one moved further away from the Lake and into the foothills. There was little response to phosphate.

TABLE I

Yields and Oil Contents of Improved Varieties of Groundnut

Oil % on dry matter basis — *Yield lb./acre shelled nuts*

Variety	Type	Chitedze I		Chitedze II		Chitala		Mbawa		Tuchila	
		Yield	Oil %	Yield	Oil %	Yield	Oil %	Yield	Oil %	Yield	Oil %
Mani Pintar*	BL	1,630	50.2	1,320	50.8	2,670	51.7	2,180	48.3	1,580	48.1
Mwitunde*	BL	760	47.8	1,080	45.5	2,090	50.6	1,270	47.0	1,160	49.7
Early Runner*	RM	490	48.9	890	49.9	1,800	49.4	—		1,780	47.0
Dixie Runner*	RL	1,140	47.2	1,130	50.1	2,020	51.1	980	45.6	1,010	45.8
Chalimbana*	RL	1,310	47.2	1,270	49.6	1,730	51.2	1,270	48.0	—	—
Amani*	RL	690	45.0	870	47.8	1,680	49.9	1,290	43.6	—	—
Gambia*	BE	470	49.8	100	47.0	1,800	51.6	—	—	1,350	48.8
A.R.S. Spanish	BE	470	47.2	320	48.7	1,760	50.5	—	—	—	—
U/A 34	RL	—	—	1,180	47.3	2,090	49.7	—	—	—	—
Makulu Red	BL	—	—	1,230	50.4	—	—	—	—	—	—
Chimbwila L11	RL	—	—	970	49.0	—	—	—	—	—	—
Chimbila L16	RL	—	—	1,080	46.7	—	—	—	—	—	—
Chimbila L17	RL	—	—	850	47.8	—	—	—	—	—	—
Gunsons	BL	—	—	430	48.9	—	—	—	—	—	—
Argentine White	BE	—	—	320	47.7	—	—	—	—	—	—
Mean of*		930	48.0	950	48.7	1,970	50.8	1,400	46.5	1,380	47.9
L.S.D. 5%		250		270				145		330	
Coefficient of variation		20.6%		15.7%				6.8%		15.8%	
Area typified		Lilongwe/ Dowa Plateau		Lilongwe/ Dowa Plateau		Salima Lake-shore		South Rukuru Valley		Palombe Plain	
Soil series		Lilongwe		Lilongwe		Chitala		Loudon		—	
Altitude ft.		3,770		3,770		1,900		4,000		2,150	
Average Temp. °F		67.0		67.0		74.7		69.4		72.5	
Rainfall 1961/62 in.		41.1		41.1		42.6		44.3		—	
Pests and Diseases		Rosette and Cercospora		Rosette and Cercospora		Cercospora		Cercospora		Cercospora	

(c) *Southern Province*

Mwitunde, Early Runner, Dixie Runner and the local runners were compared in this province. There appeared to be little to choose between them in Fort Johnston, Kasupe, Cholo or the Lower River. Early Runner showed promise in the Lisungwe and mid-Shire valleys of Blantyre and Zomba Districts, and in the South Mlanje area. Elsewhere Mwitunde gave the best all round results.

4. SEED TREATMENT TRIALS

There were two trials on this subject, one at Chitedze and one at Mbawa.

The first was a repeat of the 1960/61 3 × 4 factorial trial, combining three methods of seed preparation with four seed dressing treatments plus a control plot of unshelled seed, only there were this year six replicates, one pair planted on each of three different dates to try to encompass all sorts of planting conditions. The results are given in Table II below.

TABLE II

Effects of Seed Treatment and Type of Seed on Groundnut Yields

Variety: Mani Pintar *Yield: lb./acre shelled nuts*

Treatment	*Yield*	*Treatment*	*Yield*
Hand shelled 1961	1,920	Unshelled	1,670***
Machine shelled 1961	1,890	Shelled—no dressing	1,950
Old seed (Hand shelled 1960)	1,820*	Shelled + TMTD	1,930
L.S.D. 5%	70	Shelled + Agrosan	1,910
2 Reps. planted 18/11	2,020	Shelled + BHC	1,840
2 Reps. planted 2/12	2,010	L.S.D. 5%	90
2 Reps. planted 7/12	1,540*		
		Mean	1,860
L.S.D. 5%	370	Coeff. of Variation	7.0%

There were no significant interactions. It does not appear to be of value under conditions prevailing at Chitedze to dress groundnut seed even when dry planted. The normal precautions of using fresh shelled seed and planting early in the season should give maximum potential yields. It should be noted however that old seed gave no great reduction in yield, and that even unshelled seed could be used if there were no time to shell it. Germination from unshelled seed is however much more erratic and fields so established may therefore be more liable to attack by "rosette".

At Mbawa a 2 × 2 × 2 factorial experiment was planted with three replicates to test seed dressing with two varieties and two methods of planting. There was no response to the Thiram seed dressing and though there was no overall difference in yield between 1 and 2 drills per three foot ridge, a significant interaction indicated that while runner varieties such as Dixie Runner can be planted in a single row without loss, bunch varieties such as Mani Pintar are best drilled with two rows per ridge.

Sunflowers

1. VARIETY TRIAL, CHITEDZE

A randomized block experiment with seven varieties and six replicates was planted at Chitedze to test the varieties being maintained at the station after a number of years of selection. There was difficulty in obtaining an even stand and in preventing bird damage to the flowers, which if left in the field until properly ripe will be found to contain no seed whatever. For this reason this is a most awkward crop to deal with on a small scale.

TABLE III

Yield Data for Sunflowers at Chitedze

Variety	*Seed Colour*	*Type*	*Yield/ acre lb. seed*	*Plants per acre*	*% Oil in D.M. whole seed*	*lb./ acre Oil*
Mars	Black	Dwarf Early	1,180	10,730	29.44	350
Black Mars	Black	,,	940	9,600	26.63	250
White Russian	White	Medium earliness	1,690* 1,940***	11,610	28.33	480
Kampala White	White	and		10,490	29.54	570
Kampala	Black & White	medium height	1,660*	9,960	26.71	440
Giant White	White	Tall late	1,470	10,890	27.57	410
Giant Black	Black	,,	1,200	8,790	24.63	300
L.S.D. 5%			400	Coef. of Var. 23.7 %		

Kampala white gave the best yields of seed and oil, and was one of the more uniform varieties.

Sesame

Sesame morada was grown in observation plots at Chitala where it gave 430 lb./acre seed, and at Chitedze where it produced 600 lb./acre seed. It is a white seeded variety.

Castor

Small plots of castor of an early dwarf variety C 13 were grown and sprayed with Perenox or D.D.T. or with both, in order to try to control Inflorescence Blight. The sprayed plots, particularly those sprayed with D.D.T., remained in leaf much longer and produced more seed than the unsprayed control, but in all plots there was still a considerable incidence of the Blight.

TABLE IV

Effect of Spraying Insecticide and Fungicide on Castor Yield

Varieties sprayed fortnightly as C	*Yield/ acre lb. seed*	*Variety C 13 sprayed weekly as indicated Yield in lb./acre seed*			
			Nil	Perenox	Mean
C 4 Tall late	242				
C 5 Tall late	1,382	Nil	68	294	181
C 8 Tall late	315				
C13 Dwarf Early	360	D.D.T.	417	417	417
C14 Dwarf Early	290	Mean	242	356	299
Gunsons Medium	148				

Extract from Report of the Entomologist

GROUNDNUTS

Hilda patruelis (Issidae) was recorded but apparently caused little damage this season.

Limited investigations indicated that *Aphis craccivora*, the aphid vector of groundnut Rosette disease, was considerably less numerous on groundnuts this season than in the 1959-60 season, and less numerous than in the 1960-61 season but no detailed sampling was carried out. *A. craccivora* was recorded from pigeon-pea at Chitedze this season in breeding colonies, alates being present in March.

An unidentified Aleyrodid caused a small amount of leaf-curl in a few gardens in Southern Province, but damage was neligible.

CASTOR

A preliminary investigation was carried out concerning insect damage on castor (including the so-called "inflorescence blight"). A considerable complex of insects is to be found on castor in Nyasaland and to date more than 25 species have been recorded as causing some damage, but various species of Mirids appear to be responsible as a rule for the main damage to flowers and capsules.

The Miridae recorded are, in probable order of their importance, *Taylorilygus ricini* Taylor, *Addoxocoris apicale* Reut., *Eurystylus kivuensis* Schout., and *Eurystylus* sp. Previously it has been suggested that other organisms are responsible for "inflorescence-blight" (for example, aphids, a gall-midge and a fungus), but present evidence indicates that damage to the inflorescence is primarily caused by the above named Mirids except in some instances where lepidopterous larvae, *Helopeltis schoutedeni* or *H. anacardii* are prevalent and also concerned.

At least two species of lepidopterous larvae were found this season in the inflorescences and caused considerable damage. These larvae are quite unobtrusive and web the flowers and small capsules together to conceal themselves. *Prasinocyma angolica* Prout (Geometridae) occurred in large numbers in some areas of castor in both Central and Southern Provinces in March and April, and caused extensive damage. The small larvae are hidden in webbing in seed-capsule or inflorescence. Pupation period is from 6 to 15 days. *Orgyia mixta* Snell occurred in a number of places and caused very serious damage but only one to three plants were attacked in any one locality. This polyphagous species occurs in great numbers on a host plant as a rule, but very rarely destroys more than a few plants irrespective of the host-species. A species of Noctuid, probably *Eublemma* sp., occurred in one locality in March, causing similar damage to that of *P. angolica* but damage was confined to two or three plants only.

Extensive damage was caused in one area by *Prodenia litura* (Cotton-worm) in Southern Province on wild castor, while *Euproctis rubicosta* (Lymantriidae) also caused serious damage locally in both the Lower River and Central Province. An unidentified species of *Olethreutinae* was also recorded from castor heads but only a few specimens were found.

Other pests recorded this season included *Anoplocnemis curvipes*, an unidentified green aphid in small numbers, *Nezara* sp., *Acrosternum pallidoconspersum*, *Caura* sp., *Lygus* sp. and *Bemisia tabaci*, but neligible damage was caused by these insects.

No midge has been recorded this season, but in 1958 a wild castor plant in the Lower River was found to be slightly infested by a species of midge. This may have been *Asphondylia ricini* Mani, recorded from the northern Transvaal, but specimens were not kept and the midge has not been recorded since.

Extract from Report of the Senior Agricultural Chemist

GROUNDNUTS

Aflatoxin in Groundnuts

This toxic factor first detected in cattle and poultry feeds in 1960, was found to originate in their groundnut cake component. So far groundnuts from Nyasaland have been found to be free of this toxicity which arises from the presence of *Aspergillus flavus*. The absence of this mould in Nyasaland nuts may be due to the moisture control exercised both before purchase at markets, and during subsequent storage under adequate cover. For example market samples at purchase contain usually about 8 per cent. moisture although some samples submitted to fix the time when markets should open, have contained over 20 per cent. moisture. No doubt if such nuts had been bought and stored in that condition, mould could have developed.

Samples taken from commercial stocks during the exporting months, have shown low moisture contents, even at times of extreme atmospheric humidity caused by chiperoni conditions. Representative maximum data is shown below:—

Month	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.
Per cent. Moisture	5.6	7.2	7.3	6.9	5.3	5.8	6.2	7.1	7.4

Export Samples

One sample taken from a small portion of a Far Eastern shipment at its destination was found to contain 77 per cent. of poor nuts, the oil of which was of 26 per cent. acidity. Even that of the good seeds was 10 per cent. This indicated that the seed had become wet at some stage of transit and had not dried out adequately.

OTHER LEGUMES

Bambarra Groundnuts

Observation plots of Bambarra groundnuts were grown at Chitala and Chitedze for the record of seasonal variation of yield and for the renewal of seed stocks at Chitedze. The yields of the three most promising varieties are given below. It will be seen that phosphate did not encourage yield on these soil types (Chitala series and Kandiani series).

TABLE I

Yields of Bambarara Groundnuts

(lb./acre seed)

Variety	*Chitedze*			*Seed renewal plots (Chitedze)*	*Chitala*		
	O	*P**	*Mean*		*O*	*P**	*Mean*
Barotseland	790	710	750	800	—	—	—
N. Rhodesian	900	960	930	720	420	220	320
Mbawa D	—	—	—	650	640	430	535
Mean	845	835	—	—	530	325	

* P = 200 lb./acre single superphosphate.

Soya Beans

Dephcat fertilizer plots grown at Chitedze and Chitala showed no response to fertilizer. Yields at Chitala were very disappointing compared with those of past years.

TABLE II

Yields of Soya Beans

(lb./acre seed)

Variety	*Chitedze*			*Seed renewal plots*	*Chitala*		
	O	*P**	*Mean*		*O*	*P**	*Meau*
Benares (long term)	1,160	1,180	1,170	660	—	—	—
Malaya (long term)	—	—	—	760	100	90	95
Volstate (Medium)	—	—	—	920	330	390	360
Mean	1,160	1,180	—	—	215	290	—

* P = 200 lb./acre single superphosphate.

Bush Beans (Canadian Wonder)

Observation plots gave the following yields/acre seed at Chitedze and Chitala:—

Chitedze (*a*) Nil: 440 lb., 200 lb./acre supers: 510 lb., Planted 11/12/61.

(*b*) Nil: 240 lb., 200 lb./acre supers: 200 lb., Planted 5/2/62.

Chitala Nil: 15 lb., 200 lb./acre supers: 25 lb., failure.

Guar (Cyamopsis)

Observation plots showed no response to phosphate at either Chitala or Chitedze. Average yields were 390 lb./acre seed at Chitala and 400 lb./acre seed at Chitedze.

Cowpeas

Cowpeas plots at Chitedze were again destroyed by Ring spot (*Ascochyta* sp.), and the best yields in the observation plots at Chitedze were of the order of 100 lb./acre seed. Attempts to control the disease by spraying with Perenox were unsuccessful. An attack of small red and black leaf-eating beetles was controlled by spraying with D.D.T.

Dolichos

At Chitala plots of dolichos gave yields recorded as 1,000 lb. acre seed, but at Chitedze no yield was better than 80 lb. acre. Being very long term plants, the flowers, like those of pigeon pea, are destroyed by the *Mylabris* beetle at Chitedze.

Time of Planting Studies

Time of planting studies were conducted in duplicate plots on Kandiani series soil at Chitedze, with Canadian Wonder Beans and Bambarra Groundnuts. Though the maturity period differed little between the times of planting, yields fell markedly in both crops as planting date got later.

TABLE III

Effect of Time of Planting on Yields of Beans and Bambarra Groundnuts

Planting date	*Canadian Wonder Beans*		*Bambarra Groundnuts*	
	Days to Harvest	*Yield lb./acre seed*	*Days to Harvest*	*Yield lb./acre seed*
8/12/61	83	360	133	740
22/12/61	83–90	110	146	600
4/ 1/62	83–90	190	137	640
19/ 1/62	82	190	129	200

Pigeon Pea

Over the past two seasons, estimates have been made on the labour needed to uproot pigeon pea from a two or three year rest, and of the amount of firewood obtained.

TABLE IV

Data on Pigeon Pea used as a Resting Crop

Site and year	*Method of clearing*	*Labour required man hrs./acre*			*Firewood cu. yd/acre.*
		Cutting	*stumping*	*stack.*	*Tot.*	
Kasiya 60/61 ..	(*a*) Cut Nov. stump Jan.	29	48	77	154	200
	(*b*) Uproot January	56		113	169	200+ Leaf
Kasiva 61/62 ..	(*a*) Cut Nov. stump Jan.	29.5		57.5	—	—
Tuchila 61	Uprooted, dry season	—	—	—	62	162
Chitedze 61 ..	Uprooting, dry season	15		38	53	5

Indications from a long term experiment at Tuchila on length of pigeon pea rest are that the optimum is two years. Certainly in Central Province the crop will not survive the depredations of goats and termites for much longer. Yields of seed of the order of 200–400 lb./acre may be expected in Southern Province, but are likely to be considerably less than 200 lb./acre in Central Province where the flowers are largely destroyed by *Mylabris* beetles. Unfortunately, in tobacco growing areas, the use of pigeon pea is somewhat dangerous as it is not markedly resistant to eelworm.

Extract from Report of the Entomologist

BEANS

Agromyza phaseoli Coq. (Bean Fly) was more prevalent in Southern Province than in the last two seasons. Although Canadian Wonder Beans exhibit tolerance to Bean Fly by producing new roots above the infected part of the stem, some areas of Canadian Wonder were virtually destroyed this season, partly due to unsuitable soil conditions for the growth of new roots and partly due to the planting of other bean varieties in proximity which were a source of infestation.

Bean Fly has been successfully controlled by dressing the seed before planting with 40 per cent. Aldrin at the rate of 1 lb. per 100 lb. seed, or by spraying weekly or once in ten days with 25 per cent. D.D.T. emulsion at a rate of 2 oz. in four gallons of water, ceasing to spray when flowering commences.

A 5 per cent. solution of 50 per cent. D.D.T. wettable powder sprayed on the seedlings a few days after germination has been found to prevent oviposition, and one spraying at high volume is often sufficient to protect the crop, although not invariably so.

COWPEAS

Piezotrachelus pullus Bon. (Curculionidae) was widespread and common in Southern and Central Provinces this season, and caused severe damage in some areas. It was particularly noticeable at Balaka and other market centres. *Apion colonus* Fst. (Curculionidae) also occurred in some markets.

As high as an 88 per cent. infestation of *P. pullus* was found in some samples in markets, but the mean infestation in samples was 15 to 20 per cent. Samples were taken only from markets, not from the field. These weevils were not found in stored cowpeas or other legumes, but *Callosobruchus maculatus* and *C. chinensis* occurred in the field, in markets and in stored cowpeas and beans.

JACK BEANS (*Canavalia ensiformis*)

Late instar larvae of *Coelides foreston* Cr. (Hesperiidae) occurred in some numbers in March at Chitedze. Approximately one larva was found per 10 plants on the experimental plot. The larva is a defoliator and a leaf-roller. The rate of parasitism was comparatively high and parasites have been reared. Leaf damage on the plot was noticeable but not excessive.

Ootheca mutabilis caused considerable damage locally. This beetle is readily controlled with D.D.T.

PIGEON PEAS (*Cajanus cajan*)

The usual Meloidae caused considerable flower destruction in many areas where this crop was grown. The chief species concerned were *Mylabris tricolor* Gerst., *M. dicincta* Bert., *M. dicincta* v. *buqueti* Mars., *Coryna pilosa* Fahr. and *Ceroctis trifurca* Gerst.

ROOT CROPS

Potatoes

District trials were conducted on the Kirk Range in Ncheu and Blantyre Districts. There were two varieties, the Blight resistant Walanga, and the susceptible local Up to Date type. Combined with these were six fertilizer treatments. There was a single replicate of the 2×6 factorial at each site. The attack of Blight was heavy and the local variety was in most cases destroyed before its tubers could swell.

TABLE I

Response to Fertilizer by Potatoes in the Kirk Range

Yields: Short tons/acre potatoes with ware yield in brackets

	Ncheu District		*Blantyre District*	
	C. Mandondolo Khaza V.	*S. Lazaro Mafuta V.*	*Kantembi Nsambi V.*	*Njanjali Dambe V.*
Soil type: Texture	LS	SC	SC	SCL
Colour ..	Light brown	Red brown	Dark brown	Brown
pH ..	5.8	5.3	5.5	5.0
C.% ..	—	—	3.2	1.2
Total N.%	0.068	0.25	0.24	0.10
P p.p.m. ..	7	6	141	4
K m.e.% ..	0.30	0.36	0.3	0.4
	Walanga Local	Walanga Local	Walanga Local	Walanga Local
O Nil	4.7(2.2) 1.2(0)	4.8(2.3) 0.5(0)	4.7 1.0	2.2 2.8
N 200 lb. S/A	7.7(5.6) 2.1(0)	7.8(4.8) 0.5(0)	8.7 2.7	1.6 4.0
P 200 lb. Single Supers ..	5.4(2.5) 2.3(0)	5.1(2.5) 0.9(.1)	4.2 1.6	3.1 3.8
NP Both above	8.1(5.0) 3.6(0)	7.0(3.7) 1.0(0)	10.9 2.2	3.7 5.6
D 5 tons F.Y.M. ..	7.6(3.6) 2.2(0)	6.2(2.2) 1.0(0)	4.6 1.9	3.8 3.5
NDP all three above ..	10.9(5.9) 3.1(0)	5.9(2.2) 1.0(.2)	6.9 2.5	4.3 4.5

The main requirement seemed to be for N, but a safe dressing would be N and D or compound fertilizer containing a high proportion of N.

Other observations and statistics collected in Ncheu District are as follows:

(*a*) The average yield of Walanga fields recorded was 6 tons/acre total crop, the best unfertilized yield being 8 tons/acre and the best fertilized yield (D or ND) being 10.5 tons/acre.

(*b*) Walanga gardens planted between 17/11 and 1/12 were divided into four groups giving the following results in short ton/acre.

	Brown S.I.	*Red S.C.I.*	*Mean*
No fertilizer	5.30	6.66	5.98
200 lb. S.A	6.67	7.85	7.76
Mean	6.48	7.25	—

(*c*) Local potatoes were recorded by date of planting.

Early planted, i.e. end of October .. .. .. 1.42 short tons/acre.

Late planted, 15th-20th November .. .. .. 0.67 short tons/acre.

TOBACCO

Dark Fire-cured Tobacco

All trials have been carried out at Chitedze Agricultural Research Station on red brown sandy clay loam over sandy clay soils. Nitrogen and potassium levels are moderate and phosphate status is low. Topsoil acidity ranges from pH 5.6–6.1.

The quality of this year's crop has been fair with light filler grades predominating. *Alternaria longipes* damage lowered the quality of some of the later harvested tobacco. A high percentage of green leaf was obtained this year for reasons which are not clear.

1. VARIETY TRIAL

The trial this year was laid down on a similar basis to that of 1960/61. The object was to see whether the selections being made at Chitedze for bulking and issue to Trust Land growers were as good as or better than those selected in previous years and previously imported varieties from the United States. The 1960 selections were included again this year as their performance was not good in the 1959/61 trial. A time of planting factor was included to see if the quality of any variety was affected by different climatic conditions particularly after topping. The design was randomized blocks with six replications and with plots split for time of planting. A basic dressing of 200 lb. "C" mixture (5:15:12) and 200 lb. calcium ammonium nitrate (20 per cent.) per acre was applied to all plots.

TABLE I

Dark Fired Tobacco Variety Trial at Chitedze—Two times of Planting

	Treatment	*Yield (lb./acre)*	*Grade Index*	*Crop Index*	*Percentage Wrapper*
(*a*)	*Varieties*				
	A.R.S. 53	879	29.1	26,187	0.56
	Toleza 59	932	29.4	27,420	0.19
	Toleza 60	960	27.9	26,837	0.89
	C.D.S. 60	976	28.3	27,638	0.45
	C.D.S. 61	930	26.2	24,424	0.47
	Greenwood	950	26.8	25,493	0.46
	L.S.D. (P=0.05)	86	3.1	—	0.58
	Coefficient of Variation	11.01%	13.57%	—	136.43%
(*b*)	*Time of planting*				
	1 th December, 1961	1,014	32.0	32,519	0.91
	2nd January, 1962	868	23.9	20,758	0.11
	L.S.D. (P=0.05)	62	2.6	—	0.37
	Mean	941	27.9	—	0.50
	Coefficient of Variation	13.74%	19.84%	—	153.7%

There were no significant differences between the varieties in yield or in grade index. The 1960 selections did better than the other varieties.

Early planting with the first rains significantly improved yield, quality and wrapper percentage. The Coefficient of Variation of this latter figure was too high for the results to be of any real value.

There were no yield or quality interactions between varieties and time of planting.

2. TOPPING AND PRIMING TRIAL

A single trial was laid down this year to try to confirm last year's findings from the three topping and priming trials. The design was a 3×3 factorial with 3 replications. From a planted plot of 60 plants, 40 uniform plants were selected for harvest. As in last year's trial the standard for topping was the "Crowsfoot" defined as the top four florets and one single floret which normally open first. This crowsfoot was classed as leaf number 1 in the topping treatments.

The experiment received a basic dressing of 200 lb. "C" (5:15:12) and 200 lb. calcium ammonium nitrate per acre.

TABLE II

Topping and Priming Trial at Chitedze, 1961/62

Treatment	Yield (lb./acre)	Grade Index	Crop Index	Percentage Wrapper
(a) *Topping*				
Remove 5 leaves	1,204	43.6	52,528	0.41
Remove 6 leaves	1,116	41.5	46,400	0.18
Remove 7 leaves	1,240	38.4	47,648	0.08
(b) *Priming*				
Harvest 8 leaves	1,006	39.6	39,954	0.05
Harvest 9 leaves	1,235	43.4	53,638	0.50
Harvest 10 leaves	1,320	40.4	53,397	0.12
L.S.D. (P=0.05)	164	3.1	—	0.57
Mean	1,187	41.2	—	0.22
Coefficient of Variation	13.86%	7.48%	—	265.2%

The results show that topping 5, 6 or 7 leaves does not significantly affect yield but topping 5 or 6 rather than 7 gives a better mean grade index.

Harvesting nine leaves gave significantly better quality than eight and was almost significantly better than harvesting ten leaves.

These results confirm previous findings which showed that in an average season taking one more or one less leaf than "normal" at topping did not significantly affect yield. Also that leaving nine or ten leaves on early planted, well grown, plants would give the best yield and quality tobacco.

3. NITROGEN, PHOSPHORUS AND POTASSIUM TRIAL

This trial was identical to those held in the three previous years and the object was to determine the effects on yield and quality of these three elements. The treatments were nil, 150, and 300 lb./acre of sulphate of ammonia, nil, 250 and 500 lb./acre of single superphosphate and nil, 60 and 120 lb./acre muriate of potash per acre. All fertilizer treatments were applied within three days of planting. The design was a 3×3 factorial, single replication of 27 plots with the NPK confounded.

TABLE III

Nitrogen, Phosphorus and Potassium Trial at Chitedze, 1961/62
Planted 16th December, 1961

Yield in lb. per acre cured leaf

Sulphate of ammonia	*Single superphosphate*			
	Nil	250 *lb./acre*	500 *lb./acre*	*Mean*
Nil	537	519	550	536
150 lb./acre	557	833	776	722
300 lb./acre	595	902	1,058	851
Mean	563	751	794	781

L.S.D. (P=0.05) Interactions	163
L.S.D. (P=0.05) Main treats	94
Coefficient of Variation	13.3%

TABLE IIIA

Mean Grade Index

Sulphate of Ammonia	*Single superphosphate*			
	Nil	250 *lb./acre*	500 *lb./acre*	*Mean*
Nil	26.1	19.5	20.8	20.2
150 lb./acre	19.6	34.8	30.1	28.2
300 lb./acre	18.7	39.9	37.1	28.6
Mean	19.5	28.1	29.3	25.7

L.S.D. (P=0.05) Interactions	7.3
L.S.D. (P=0.05) Main treats	4.4
Coefficient of Variation	16.3%

The results of this experiment have been presented as two way tables as they demonstrate very forcibly the inter-relationship now found between nitrogen and phosphorus and their effect on tobacco at Chitedze. The main treatment results show an apparently significant response to 150 lb. of sulphate of ammonia in both yield and quality and a further significant response in yield but not quality to an additional 150 lb./acre sulphate of ammonia. However the interactions show that in fact there was no yield response and a negative quality response to sulphate of ammonia in increasing quantities unless it was applied with superphosphate. Similarly with single superphosphate, no yield response and a negative quality response occurred at all levels except in the presence of sulphate of ammonia. The maximum response to sulphate of ammonia occurred only in the presence of 500 lb./acre of single superphosphate.

Muriate of potash had no significant effect on yield or quality. Despite the very apparent field affects of nitrogen and phosphorus on yield and grade index there was no effect on the percentage of wrapper leaf produced which was too low to analyse.

4. DISTRICT TRIALS

Small trials were held in 4 market areas to try to confirm the findings of the Village Garden Soil Survey which showed that the phosphate levels were low in most Trust Land tobacco areas. Sites were chosen in villages with soils of low phosphate content and 5 yard by 30 yard plots of nil fertilizer, 300 lb./acre of 10:9:0 mixture and 180 lb./acre sulphate of ammonia laid down without replication.

TABLE IV

Summary of Results of District Trials, 1961/62

lb. Cured Leaf

Available Phosphate p.p.m.	*No. of sites*	*Mean response to Sulphate of Ammonia*	*Mean response to 10:9:0*
1	8	283	683
2	2	442	448
3	3	191	457
28	1	245	16

The summary of results shows that where phosphate levels are low the application of a phosphate fertilizer can have a profound effect on yield of tobacco. But where phosphate levels are adequate then sulphate of ammonia alone should be applied. The effect on quality was not clear as grading was carried out in the field and the standards employed may not have been comparable.

5. CURING TRIALS

Following renewed interest in the method of curing Dark-fired Tobacco as it affects the final quality of leaf produced, preliminary curing observations were undertaken. The American or "Soft Cure" in which the temperatures and humidities throughout curing are lower than the Nyasaland "Hard Cure," was compared with three variations of the Hard Cure. These were (*a*) curing of midribs in open sided barns, (*b*) 24-hour firing for curing midribs and (*c*) one day without fire between lamina and midrib cures, as compared with the normal cure in which midribs are cured in the barn with firing carried on 12 hours a day with no break between lamina and midrib cures. Presuming the leaf going into the barn was of even ripeness and wrapper potential, as it appeared to be, the aim was to see whether any of these methods produced higher wrapper percentages than in the standard cure. Results are shown in Table V.

The outside midrib cure produced leaf of a better colour and texture than the American cure which, while giving generally heavier bodied leaf than the other cures produced leaf of rather a harsh texture. The technique employed for the American cure may not yet be quite right as this was the first attempt. The other two cures produced very dark and mottled leaf due to sweating in the barns.

Based on this one year's work there is an indication that the lower temperatures of the soft cure enables heavier leaf to be produced although there still appears to be loss of elasticity. Whether this is lost before the leaf goes into the barn or during curing

is not known. Further work on curing is in hand for the coming season and it must be noted that the above results are based on single barns of each cure and are only very early investigations.

TABLE V

Results of Curing Observations Chitedze, 1961/62

Treatment	*Mean Grade Index*	*Wrapper %*
(1) American Soft Cure	26.62	0.07
(2) Outside midrib cure in open shed	44.46	0.10
(3) 24-hour midrib curing	30.11	0.11
(4) One day gap between lamina and midrib curing	18.24	0.08
(5) Normal*	27.90	0.50

* Means from Variety trial results

Burley Tobacco

The one trial this year was carried out at Chitedze Agricultural Research Station, Lilongwe, on red-brown sandy clay loam over sandy clay soils. Nitrogen and potassium levels are only moderate whilst the phosphate status is low. Topsoil acidity ranges from pH 5.3–6.1.

A comparatively low percentage of length one leaf (over 23 in.) was produced this season possibly due to overcast conditions throughout January which reduced crop growth. This year saw the introduction of the new "tan" grade which is intermediate between the red and coloury grades in colour. Production of the coloury grades was low but high percentages of the tan grades occurred. *Alternaria longipes* started in the crop in mid-February and reached epidemic proportions in the later planted Burley and consequently reduced quality of this tobacco.

Within the tables of results any leaf not accounted for as red, coloury or tan was graded out as green, X, or waterstained, black, and mouldy.

Although due to staff shortage only one formal experiment was laid down, many valuable observations have been made.

1. VARIETY TRIAL

Three of the varieties tested in the 1960/61 trial were compared with Barnet Special the standard Nyasaland type producing dark red leaf and with Kentucky 41 and Gay's Yellow which in previous years had given high coloury percentages and high grade indices respectively. Thus there were a total of six varieties in the experiment. One object of the trial was to study the varieties with a view to production of cigarette quality "fluffy" Burley tobacco for Nyasaland. A time of planting factor was included with two dates of planting (*a*) early with the first rains and (*b*) two weeks later, so that any early maturing varieties would not be at a disadvantage by being cured in the wettest part of the season. The trial was laid down as a 2×6 factorial with six replications and all plots received a basic dressing of 200 lb. "C" mixture (5:15:12) and 200 lb. calcium ammonia nitrate (20 per cent.) per acre.

TABLE VI

Burley Variety Trial at A.R.S. Chitedze, 1961/62

Treatment	Yield lb./acre	Grade Index	Crop Index	% Coloury	% Tan	% Red
(a) *Variety:*						
Barnet Special	1,338	20.13	26,930	4.42	11.92	50.94
Briarvet	1,257	29.15	36,633	12.66	17.42	53.77
Gay's Yellow	1,194	26.48	31,617	5.64	12.69	61.88
Burley 21	1,181	16.97	20,050	10.75	9.08	41.56
Kentucky 41	1,329	24.58	32,677	12.94	12.38	48.58
Mammoth Kentucky	1,212	22.76	27,594	5.73	15.47	52.52
L.S.D. (P. = 0.05)	147	2.64	—	2.34	2.90	6.39
(b) *Time of Planting:*						
Early December 16th 1961	1,375	22.68	31,163	11.88	12.31	52.30
Late January 2nd 1962	1,149	24.01	27,595	5.50	14.00	50.80
L.S.D. (P. = 0.05)	85	1.53	—	1.35	1.67	3.69
Mean	1,252	23.34	—	8.69	13.16	51.54
Coefficient of Variation	14.2%	13.8%	—	32.8%	26.8%	15.1%

There were no significant differences in the " F " test between the yields of the varieties. Barnet Special gave the highest actual yield with Kentucky 41 only slightly less. Both Gay's Yellow and Burley 21 yielded 100 lb./acre less than the two top varieties.

Briarvet gave significantly better quality than the other five varieties while Burley 21 was significantly worse than the remaining three varieties. Gay's Yellow produced the most red leaf while Briarvet and Mammoth Kentucky produced significantly more tan leaf than the other varieties.

Early planting significantly increased yield over late planting. Although early planting had no effect on quality as measured by grade index it produced significantly more coloury leaf and less tan leaf than late planting. Time of planting did not affect the percentage of red leaf produced.

Barnet Special must remain as the best variety for high yield and production of high percentages of traditional Nyasaland Red Leaf. However for the production of cigarette quality tobacco Briarvet and Kentucky 41 seem the most promising varieties.

2. PRODUCTION OF CIGARETTE QUALITY BURLEY

Observations this year have shown that early planting (i.e. dry planting in mid-November) and controlled curing in specially constructed barns during the wettest period of the year can give high percentages of light coloured leaf. Most of this work is still at an early stage and will be reported on further next year but the chemical findings from the curing experiments are reported below.

Extract from Report of the Agricultural Chemist, Chitedze

BURLEY TOBACCO

The Effect of Controlled Curing on the Chemical Composition of Leaf.

Leaf harvested samples of the three main grades of several varieties grown at Chitedze, were examined for percentage nicotine, N, P and K, after they had been cured in one of two ways;

(a) *normal cure* in a standard barn subject to high humidities for long periods.

TABLE VII

Chemical Composition of Burley Leaf after Normal and Controlled Curing

(100 *per cent. dry matter basis*)

Variety	*Grade*	*Barn A (normal)*				*Barn B (controlled)*			
		Nicotine	*N*	*P*	*K*	*Nicotine*	*N*	*P*	*K*
* Burley 21	Coloury	2.72	3.18	.35	4.95	1.57	2.73	.31	6.27
	Tan (middle)	3.66	3.56	.30	4.81	1.77	2.88	.28	6.07
	Red	4.27	4.34	.27	3.85	1.97	3.18	.27	5.09
* Briarvet..	Coloury	3.71	3.23	.36	4.88	2.27	3.01	.29	5.82
	Tan (middle)	4.90	3.82	.31	3.92	2.42	3.18	.26	5.36
	Red	6.26	4.36	.32	3.20	4.81	3.87	.27	4.20
† Barnet Special	Coloury	1.53	2.62	.35	5.94	1.14	2.33	.23	6.00
	Tan (middle)	3.58	3.09	.33	4.37	1.74	2.68	.27	5.28
	Red	4.60	3.51	.24	3.48	2.38	2.92	.26	5.14

*mean of four determinations

† mean of two determinations

(*b*) *controlled cure* in a specially designed barn containing longitudinal flues which were fired on three days when their relative humidity (R.H.) was high. The temperature was not allowed to exceed 95° F. the aim being to achieve a mean R.H. of 65–70 per cent. throughout.

The effects of these two types of curing on chemical composition of the leaf are shown in Table VII.

Apart from the obvious difference in composition between the various grades shown by either method of curing, the main effect of the controlled cure is that of substantially reducing the nicotine and N content in all grades when compared with those found after normal curing. Though P content would seem to be little affected a slight reduction is noted where controlled curing is used while the potash content is much increased. It would appear therefore that curing, which takes place initially in N's under conditions [illegible] carefully controlled, favours the production of a considerable quantity of light coloured leaf of low nicotine content and good quality, which at present is greatly in demand.

Leaf v. Stalk Harvesting and its Effect on Chemical Composition

Samples of coloury, tan and red leaf of the same variety, which had been either leaf or stalk harvested were examined for any differences in chemical composition brought about by the two methods of harvesting. The results are given in Table VIII.

TABLE VIII

Leaf versus Stalk Harvesting (Barnet Special)

(100 *per cent. dry matter basis*)

Grade	*Nicotine**		*N**		*P**		*K**	
	L	*S*	*L*	*S*	*L*	*S*	*L*	*S*
Coloury ..	1.32	2.00	2.37	1.73	.45	.33	6.67	6.01
Tan	3.43	3.21	3.23	2.54	.30	.22	5.24	5.36
Red	5.44	4.28	4.82	3.62	.21	.23	3.95	4.61

* mean of three determinations L = leaf harvested S = stalk harvested

These results confirm findings elsewhere (Mohr, Garner *et al.*) which show that variations in chemical composition arising from the two contrasted harvesting procedures are largely due to differences in movement and translocation of materials from the leaf. When the leaves are attached to the plant, considerable transference of material occurs from leaf to stalk, and this particularly applies to the movement of nitrogen. Where leaves are detached from the plant however chemical changes are due largely to internal transformations and any movement of materials is restricted to that between lamina and midrib.

In order to obtain the maximum amount of light coloury leaf with low nicotine content the future policy at Chitedze will be to leaf harvest the flyings and primings and then to stalk harvest the remainder of the plant. This method of harvesting should also prove to be much more economic.

Chemical Composition, Burley Varieties, Chitedze, Early and Late Planted.

Data are presented in Table IX showing differences in leaf composition between the three main grades of six Burley varieties grown at Chitedze. In addition variations in composition between early and late plantings are also given.

TABLE IX

Early and Late Plantings

(100 *per cent. dry matter basis*)

Variety	*Grade*	*Nicotine**		*N**		*P**		*K**	
		E	*L*	*E*	*L*	*E*	*L*	*E*	*L*
Barnet Special	Coloury	2.07	2.61	2.83	3.17	.39	.31	6.20	6.12
Briarvet		2.22	2.13	3.08	3.16	.36	.34	5.66	5.92
Burley 21 ..		1.68	1.87	2.81	3.13	.32	.32	5.30	6.08
Kentucky 41 ..		1.62	1.91	2.80	3.15	.33	.30	6.41	6.55
Gay's Yellow		1.75	2.38	2.60	3.22	.35	.29	6.02	6.10
Mammoth Kentucky		2.04	2.60	2.98	4.06	.32	.28	6.04	5.80
Barnet Special	Tan	3.08	2.74	3.27	3.28	.32	.26	5.19	5.24
Briarvet		3.40	3.20	3.56	3.78	.30	.25	4.61	4.74
Burley 21		2.27	2.58	3.29	3.39	.31	.26	5.11	5.25
Kentucky 41		3.19	3.83	3.51	3.65	.28	.28	4.74	4.80
Gay's Yellow		2.57	3.08	3.40	2.85	.30	.25	5.06	4.76
Mammoth Kentucky		2.92	3.72	5.32	3.08	.32	.28	5.36	5.49
Barnet Special	Red	4.60	4.12	4.18	4.62	.23	.22	3.84	4.06
Briarvet		5.80	4.92	4.74	4.95	.24	.24	3.12	3.24
Burley 21		4.86	4.02	4.77	4.76	.24	.24	2.75	3.34
Kentucky 21 ..		5.31	4.29	4.88	4.52	.22	.19	3.05	3.68
Gay's Yellow		6.55	4.64	5.03	4.89	.23	.21	2.87	3.50
Mammoth Kentucky		5.37	4.51	4.74	4.72	.24	.20	2.95	3.07

* means of duplicate samples

Coloury and Tan Leaf

The consistently higher N figures in the late planted leaf are not always associated with nicotine content, but with greater replication of samples this could probably be anticipated. P appears to be slightly less in the later plantings, while K differences are rather inconclusive.

Red Leaf

Nicotine content is considerably higher in the early planted leaf though N levels are variable. P figures are virtually the same for both plantings though much reduced when compared with the lighter leaf grades. K content is markedly higher in the late planted leaf and ties in well with the lower nicotine figures obtained from this planting.

DARK-FIRED TOBACCO

Chemical Composition, Dark-fired Varieties, Chitedze

Heavy and light filler grades of six varieties were examined for nicotine, N, P and K content. Details of analysis are given in Table X.

An expected general reduction in nicotine and N content from heavy to light filler is shown. P shows little change while K with one exception increases in the lighter leaf. The figures are typical for the general range of these constituents as found in Nyasaland dark-fired leaf, and can be contrasted with those obtained for the six Burley varieties, and given in Table IX.

TABLE X

Chemical Composition, Dark-fired Varieties, Chitedze

(100 per cent. dry matter basis)

Variety	Nicotine*		N*		P*		K*	
	H.F.	L.F.	H.F.	L.F.	H.F.	L.F.	H.F.	L.F.
T60	7.86	7.01	4.78	4.70	.25	.24	2.75	3.04
Sel 60 ..	7.76	6.71	4.99	4.52	.24	.24	2.68	3.04
A R S 53 ..	7.47	6.81	4.96	4.42	.22	.23	2.63	2.95
Greenwood ..	8.10	6.93	4.89	4.34	.23	.25	2.57	2.88
T 59	7.74	7.01	4.62	4.64	.23	.23	2.72	3.03
Sel 61 ..	7.89	6.89	4.62	4.36	.22	.24	2.88	2.63

* means of duplicate samples H.F.=heavy filler L.F.=light filler

Chlorine Content of Cured Leaf

Samples of light filler, taken from a trial where three rates of N, P and K (as KCl) were applied in all combinations, were examined for any variations in chloride content of the leaf. The main effects and interactions are set out in Table XI.

TABLE XI

Effect of Variable Rates of N, P and K on Chlorine Content of Dark-fired Tobacco

(reported as per cent. CL—100% D.M. basis)

	P_0	P_1	P_2	K_0	K_1	K_2	Main effects
N_0	.408	.331	.316	.134	.326	.595	.352
N_1	.246	.241	.143	.063	.188	.379	.210
N_2	.184	.244	.230	.051	.293	.314	.219
K_0	.057	.075	.116				
K_1	.327	.216	.264				
K_2	.454	.524	.309				
Main effects	.279	.272	.229	.082	.269	.421	—

L.S.D. Main effects	P=0.05	.152
	P=0.01	.222
L.S.D. Within body of table	P=0.05	.264
	P=0.01	.385
Coefficient of Variation=	53.9%	

N_0=nil, N_1=150, N_2=300 lb. S/A per acre.
P_0=nil, P_1=250, P_2=500 lb single supers per acre.
K_0=nil, K_1=60, K_2=120 lb. KCl. per acre.

The results clearly show that highly significant increases in chlorine uptake occur when KCl is applied alone, and that a balanced nutrient supply is therefore essential to counteract this effect. However if no KCl is added amounts of chloride are likely to be very low and this is not altogether desirable. Within the body of the table the chlorine

content declines significantly with the addition of fertilizer nitrogen, this trend also being reflected in the main effect of N. A similar trend is shown when phosphate is added but does not reach significance.

Additional samples were examined which had been grown with either muriate (KCl) or sulphate (K_2SO_4) of potash. Chlorine content where KCl had been applied averaged .437 per cent. while with K_2SO_4 it was only .106 per cent. These figures agree well with those obtained above.

While recent investigations state that a chloride content of above 0.6 per cent. is detrimental to the burn, nonetheless the presence of chlorides in quantities somewhat less than this would seem to be desirable to promote greater elasticity of the cured leaves and in preventing necrosis due to drought. Therefore in order to maintain supplies at a reasonable level the use of KCl would appear to be necessary and preferable to K_2SO_4.

Extract from Report of the Senior Agricultural Chemist

TOBACCO (FLUE-CURED)

1. FERTILIZER RECOMMENDATIONS

For the coming season (1962-63), 213 samples (116 top) have been examined. This shows a slight reduction on last year, viz. 276 (140 top), but several estates, where recommendations over several years have shown their fields to be uniform, or where the nitrogen requirement is rather low, appear to be basing their plans on previous experience. Generally, the nitrogen levels advised are being increased in those areas where the soils mineralize rather slowly, or where better crop management will now tolerate more nitrogen. However, as shown below in section 2, increased levels of nitrogen may have an effect on leaf composition which is not reflected in the visual appearance of the plants or the grade index, but which may become of importance at a time when the assessment of chemical components in the leaf is becoming as important as physical characteristics.

2. EFFECT OF HIGH LEVELS OF NITROGEN

In the NPK experiment at Makoka, the highest level of nitrogen was 60 pounds, greater than ever previously applied. The plants in these plots grew well, and without any undue greenness. It was therefore desirable to see whether the nitrogen content of the soils, or leaf had been affected. Samples were therefore taken at the end of January, from plots with high and low levels of nitrogen and potassium fertilizers. Soils were taken in triplicate and leaf in duplicate. The resultant data is summarized in Table XII.

TABLE XII

Effect of high nitrogen levels

	Soil Nitrogen per cent.		*Mineralizable Nitrogen p.p.m.*		*Nitrogen per cent.*		*Av. weight (gms.)*	
24 *lb. N*	**0–4″**	**8–12″**	**0–4″**	**8–12″**	**8th Leaf**	**14th Leaf**	**8th Leaf**	**14th Leaf**
***a.* low K**	.098	.082	61	68	1.18	1.52	47	41
***b.* high K**	.080	.072	46	42	1.34	1.34	50	47
60 *lb. N*								
***a.* low K**	.065	.060	38	45	1.60	2.10	49	50
***b.* high K**	.082	.082	76	58	2.0	2.14	44	45
Very green Leaf ..	.077	.070	44	47	1.39	2.31	60	82

Although the level of nitrogen application is not reflected by the differences in the soil nitrogen status, it may be noted that for adjoining unfertilized soil the nitrogen percentage in top and sub soils was .064 and .057 respectively. The leaf composition gave a more interesting picture. The 60N plots containing leaf of 1.8 and 2.1 per cent. nitrogen, compared with figures of 1.3 and 1.5 per cent. respectively in the 24N plots. The corresponding data for leaf from the bulk crop on field D3, was 1.2 and 1.6 per cent. respectively, which ties in well with the level of 24 pounds of nitrogen used. The average weight of this leaf was 51 and 42 grammes respectively.

The samples referred to as " very green " in the table, came from a small area near the experimental site where apparently a double application had been made, or fertilizer bags had stood. These plants were much greener and heavier than those even on the 60N plots. The nitrogen content of the 8th leaf is less than in those from the 60N plots, but that of the 14th leaf is higher. The leaves themselves are however much heavier, giving an almost threefold increase in total nitrogen per 14th leaf over the amount contained in leaf from the 24N plots.

This brief examination was made to obtain some indication (before analysis on the cured leaf was complete) of the extent to which nitrogen levels could be increased in those areas where crop management was sound or where recommendations had been on the low side on areas of soils of lower mineralization rates. Although the 60N plants appeared 'quite satisfactory' in the field, there is the indication that the leaf content of nitrogen, and hence of nitrogen compounds is affected. As the present demand is for milder tobacco, this is an aspect that will have to be watched.

3. CHLORIDE UPTAKE

The experiment made last season to investigate any relation between "slatey" leaf and chloride uptake, was repeated. However, the rainfall distribution was again such that no excessive dry period occurred, and little slatey leaf was found. Chloride levels of nil (two pounds from impurities), 15 and 50 pounds per acre were used, derived respectively from 550 pounds "B" mixture, 550 pounds "V" mixture, and the latter supplemented by 60 pounds of common salt (X). In each case 15 pounds of potassium sulphate were also added. 192 leaf samples were analysed for chloride content of the the lamina (L) and midrib (M), the data being summarized in Table XIII all figures being on a dry weight basis. The general picture is similar to that obtained last year, except that earlier in the season the chloride content was higher, and at the end of the season the level in the last leaves of the final planting was lower than last season. Thus, the first leaf laminae on Block 1 had percentages of 3.5 on the B treated plots rising to 6.2 in X. These figures compare with 1.8 and 3.1 last year. It may be noted in this connection that there was a fortnight's dry period immediately before the first samples were taken this year, compared with a rainfall of four inches in the corresponding period last season. In the February sampling, the "X" plots on the third planting contained appreciably less chlorine, being .1 - .2 in the laminae and .7 in the midribs, compared with .4 - .5 and 2.4 - 2.7 respectively last season. This could be explained by the fact that the rainfall in the two weeks prior to collection of these samples was five inches against three inches in the equivalent period last season. In addition rain fell evenly throughout January, whereas in the previous year, there were two weeks with very little rain.

Cured leaf from this experiment was also examined for chlorine content, the data being summarized in Table XIV. Bearing in mind that the green leaf samples were numbered above the " cutters " level, it is seen that there is a greater chloride content in the midribs of the cured leaf, apparently due to migration during curing. This difference is particularly noticeable in the second planting.

TABLE XIII

Chloride Uptake in Flue-Cured Tobacco

Leaf No.	Samples taken December 12th						Samples taken January 22nd						Samples taken February 22nd					
	B		V		X		B		V		X		B		V		X	
	L	M	L	M	L	M	L	M	L	M	L	M	L	M	L	M	L	M
Block I—Planted November 8th																		
1	3.5	4.9	3.5	6.3	6.2	7.6												
5	1.7	3.5	2.0	2.9	3.3	3.5	.19	1.4	.28	1.6	.33	1.6						
8	1.2	1.8	1.5	2.7	2.4	2.2	.16	1.3	.19	1.3	.37	1.6						
12							.19	1.3	.26	1.7	.44	1.8	.09	1.1	.19	1.0	.26	1.7
Block II—Planted November 22nd																		
1	2.7	3.3	3.7	5.4	3.5	4.3	.19	.83	.28	1.1	.82	1.8						
5							.32	1.0	.63	1.1	.73	1.6						
8/9							.34	.98	.47	.85	.66	1.0						
12													.12	.82	.21	1.3	.22	1.2
Block III—Planted December 9th																		
1							.19	.47	.30	.73	.61	1.5						
5							.18	.46	.22	.62	.44	1.0						
9													.06	.23	.19	.52	.11	.67
12													.18	.28	.13	.62	.16	.79

TABLE XIV

Chloride Content of Cured Leaf

Reaping		1	2	3	4	5	6	7	8	9	10	11
							1st Planting					
Date		29/12	4/1	11/1	18/1	27/1	30/1	6/2	12/2	21/2	26/2	2/3
'B'	L	2.7	1.4	.57	.26	.32	.13	.15	.17	.23	.24	.26
	M	5.2	3.4	2.8	1.4	1.9	1.1	1.3	1.5	1.8	2.0	2.7
'V'	L	4.8	2.5	1.1	.47	.31	.24	.19	.24	.27	.24	.39
	M	8.6	5.5	3.4	2.4	2.0	1.7	1.8	1.9	2.2	2.2	2.6
'X'	L	5.9	3.3	1.5	.88	.41	.30	.22	.24	.28	.28	.27
	M	8.6	5.7	3.8	2.8	2.4	1.9	2.1	1.9	2.2	2.5	3.1
							2nd Planting					
Date		12/1	18/1	27/1	30/1	6/2	12/2	21/2	26/2	2/3		
'B'	L	.43	.27	.49	.27	.21	.19	.20	.26	.36		
	M	1.9	1.3	.84	1.1	1.3	1.4	1.5	2.2	2.1		
'V'	L	.93	.65	.68	.73	.53	.42	.28	.41	.55		
	M	3.0	2.4	1.9	2.1	2.2	1.9	1.9	2.3	2.8		
'X'	L	1.2	1.2	1.2	1.2	.74	.75	.46	.53	.66		
	M	3.3	2.8	2.5	2.4	2.2	2.3	2.5	2.7	3.0		
							3rd Planting					
Date		27/1	30/1	6/2	12/2	21/2	26/2	2/3	2/3			
'B'	L	.05	.07	.06	.05	.09	.17	.19	.32			
	M	.29	.42	.40	.33	.60	1.0	1.2	1.7			
'V'	L	.29	.21	.15	.18	.16	.34	.37	.52			
	M	.82	.95	.84	.95	.95	1.7	1.8	2.1			
'X'	L	.68	.48	.48	.24	.27	.30	.37	.40			
	M	2.0	1.7	1.7	1.3	1.6	1.8	2.1	1.8			

COTTON

Cotton Agronomy

1. TIME OF APPLICATION OF NITROGEN TRIAL, CHITALA

In order to find out the best time to apply small dressings of sulphate of ammonia to cotton on Chitala series soil, a randomized block experiment of five treatments and four replicates was laid out at Chitala on a soil with the analysis as follows:–

Texture S.L.; pH=6.1; Total N=0.082 per cent. ;

Available P=2 p.p.m.; K=0.60 m.e. per cent. The variety planted was Albar 637, and there was no basal dressing of P or K.

TABLE I

Effect of time of application of Nitrogen on Cotton

Treatment	*Yield/ acre lb. seed cotton*	*% Grade II*	*Height in.*	*No. of shed bolls per plant*
No fertilizer	1,330	5.0	34	5
200 lb./acre S/A Banded before planting ..	1,610	4.3	38	8
200 lb./acre S/A Dollop placed at germination	2,050	5.3	44	9
200 lb./acre S/A Dollop placed at 1 month ..	1,970	4.8	46	10
200 lb./acre S/A Dollop placed at 1st flower ..	1,830	5.5	41	10
L.S.D. 5%	200			
Mean	1,760	Coefficient of Variation		7.2%

The crop was planted at the standard spacing of 3 ft.×2 ft.×3 plants and was blanket sprayed with Sevin and D.D.T. to control Red and American bollworm. There was a large response to nitrogen as sulphate of ammonia, and it was best applied in dollop placement within a month of germination.

2. NPK AND SPACING TRIAL, CHITALA

This was a repeat of last season's exploratory fertilizer trial under blanket sprayed conditions on Chitala series soil. The design was a $2\times2\times2\times3$ factorial with two replicates. The phosphate and potash were applied banded in the ridge tops before planting and the nitrogen was top dressed in dollops three weeks after germination. The soil analysis showed: Texture S.C.L.; pH 6.3; N=0.070 per cent.; available P=1 p.p.m.; K=0.71 m.e. per cent. The yield was subdivided into its 1st, 2nd and 3rd pickings. The standard population was tried in three spacings.

TABLE II

Effect of fertilizer and spacing on Cotton Yields

Treatment	Total yield lb./acre seed cotton	% of crop in Pickings 1st	2nd	3rd	Total % Grade II	% Grade II Pickings 1st	2nd	3rd	Height in.	No. of sheds per plant
N_0 — Nil	1,060	58	32	10	2.5	1.4	2.0	11.4	34	8
N_1 — 200 lb./acre S A ..	1,580***	58	35	7	3.2	2.4	3.1	11.3	45	11
P_0 — Nil	1,310	57	34	9	2.8	1.5	2.6	13.3	39	10
P_1 — 200 lb./acre Supers	1,330	59	33	8	2.8	2.2	2.6	9.4	40	9
K_0 — Nil	1,310	58	34	8	3.0	1.9	2.6	13.2	38	9
K_1 — 50 lb./acre KCl ..	1,320	58	34	8	2.7	1.9	2.5	10.3	40	9
L.S.D. 5%	80									
S_1 3 ft. × 24 in. × 3 plants	1,330	56	35	9	2.8	2.0	2.4	11.0	41	7
S_2 3 ft. × 16 in. × 2 plants	1,280	58	34	8	3.0	1.9	2.7	12.2	39	10
S_3 3 ft. × 8 in. × 1 plant ..	1,340	60	32	8	2.9	1.8	2.9	12.0	38	10
L.S.D. 5%	100									
Mean	1,320					Coef. of Variation = 10.7%				

1st pick = 1/5/62 2nd pick = 21/5/62 3rd pick = 20/6/62 Planted 4/12/61

This year the spacing made no difference to yield, and there was a marked response to nitrogen, which as last year made the plants taller and slightly increased the proportion of Grade II cotton. There were again no responses to phosphate or potash in spite of the very low figure for available phosphate in the soil analysis. The later the crop is picked, the higher the proportion of Grade II stained cotton. Hill spacing tends to delay the crop as compared with single plant spacing. Variety was Albar 637.

3. POPULATION TRIAL, CHITALA

This trial was a repeat of last season's trial, except that this year all population treatments received a uniform basal dressing of 200 lb./acre sulphate of ammonia and 200 lb./acre single superphosphate. The design was thus a randomised block experiment with four replicates. The soil was a Chitala series S.C.L. with pH 6.2 and low in both N. and P.

TABLE III

Effect of population on Cotton Yields

Treatment	Actual No. of Plants	Total yield lb./acre seed cotton	% Grade II	% crop in Pickings 1st	2nd	3rd	Symp. nodes/ plant	Bolls/ plant	Sheds/ plant
3 ft. × 24 in. × 3 plants (21,780)	20,300	1,130	2.4	58	36	6	20	9	7
3 ft. × 24 in. × 1 plant (7,260)	7,110	1,070	2.0	58	38	4	44	23	13
3 ft. × 12 in. × 1 plant (14,520)	13,640	1,140	1.6	57	37	6	26	9	11
3 ft. × 8 in. × 1 plant (21,780)	20,390	1,190	2.5	64	30	6	24	10	10
3 ft. × 6 in. × 1 plant (29,040)	26,320	920*	2.3	64	30	6	16	5	9
3 ft. × 4 in. × 1 plant (43,560)	34,570	1,160	2.9	48	42	10	24	7	12
L.S.D. 5%		200							
Mean		1,100	Coefficient of Variation 12.3%						

As last year there was no effect on yield of populations ranging from 7,000 to 35,000. Cotton is very well able to adapt itself to a great variation in population. In North Australia recently, a range of 8,000-32,000 plants was recorded as having no effect on yield, though the higher the plant population in rows drilled 3 ft. apart, the greater was the percentage of crop in the first pick. There is evidence in the above figures to support this. Variety was Albar 637.

4. SPACING AND POPULATION TRIAL, BAKA (KARONGA WINTER CROP)

A 3×2 factorial experiment with four replicates was laid out on Karonga series alluvial soil at Baka, to test the effects of two interhill spacings on 3 ft. rows and 1, 2 or 3 plants per hill. There were no significant yield differences, as is shown in Table IV.

TABLE IV

Effect of spacing and population on Winter Cotton Grown on 3 ft. ridges

Population/acre in brackets Variety: ALBAR 637 Yields: lb./acre seed cotton

	Number of plants per hill 1	2	3	*Mean*
3 ft. × 1 ft. spacing ..	1420 (12,670)	1550 (21,780)	1450 (31,080)	1475 (21,840)
3 ft. × 2 ft. spacing ..	1265 (6,520)	1325 (12,190)	1255 (15,370)	1280 (11,360)
Mean	1340 (9,600)	1435 (16,990)	1350 (23,230)	1375

L.S.D. 5% Centre table .. 370
Spacing .. 215 Coefficient of Variation 17.8%
Plants per hill .. 260

5. TIME OF PLANTING AND VARIETY TRIAL, BAKA (KARONGA WINTER CROP)

A 3×2 factorial experiment with four replicates was laid out on Karonga series alluvial soil at Baka to test two varieties of cotton at three times of planting. The coefficient of variation was very high (22.3 per cent.), and yields in no way compared with boll counts taken in October, so the results must be taken with some scepticism. There was no difference in yield recorded between Albar 637 (1050 lb./acre seed cotton) and C.L.B. (1005 lb.). Nor was there any difference between planting dates, the complete experiment being picked over on two dates only, October 11th and November 6th. Times of planting were April 30th (1140 lb.), May 15th (1000 lb.), and May 29th (950 lb.).

6. RAT BAIT OBSERVATION, KAFIKISILA (KARONGA WINTER CROP)

For the second year there was no indication that application of 'Sorexa' rat bait in a band round the outside of the cotton plot had any effect on rat damage to the cotton within the perimeter. Mean yields were 2400 lb./acre seed cotton in 1960 and 2100 lb. seed cotton in 1961. As cotton can adjust itself to such a wide range of populations and the growing conditions at Kafikisila are evidently excellent, the aim should be to prevent too great a build up of the rat population by regular baiting and poisoning of burrows by specialist rat catchers, rather than for farmers to try to 'dress' their crop.

7. VARIETY TRIALS, KARONGA LAKE-SHORE

Two variety trails were laid out during the winter of 1961, one on Karonga alluvium at Baka under 'dry land' conditions, and the other on a hydromorphic soil of Mwenitete series at Kafikisila under 'dimba' conditions. The design was randomized blocks with four replicates. Results are given in Table V and require no comment.

TABLE V

Yields of Winter Cotton Varieties on Karonga Lake-shore

Varieties	*Baka Karonga series lb./acre seed cotton*	*Kafikisila Mwenitete series lb./acre seed cotton*
A637	790	2,230
A56	700*	2,180
512	960	1,740
515	910	1,830
519	810	2,070
524	850	1,750
U.P.A.	730*	1,930
C.L.B.	690*	1,770
L.S.D. 5%	230	540
Coefficient of Variation ..	16.5%	18.9%

* Significantly poorer than the highest yielder (black).

Makanga

INTERPLANTING TRIAL COTTON AND MAIZE

A comparison between pure stands of cotton and maize and the two crops planted in alternate rows was carried out using a randomized block design with seven replications. The late arrival of planting rains precluded early and late planting comparisons, the trial being planted on 15th December.

At both the planting and refilling stage maize seed was heavily attacked by harvester termites and poor stands resulted. Cobs on laid plants were damaged by termites later and this coupled with the long dry spell in February and early March resulted in a poor yield. The plant population in the pure maize stands was just under 50 per cent. while that in the interplanted maize was 62 per cent.

The results given in Table VI show no significant differences in the yield of cotton but a large part of the increase in maize yields would be due to the disparity in plant population.

TABLE VI

Interplanting of Cotton and Maize, Makanga

System	*Yield in lb.*	
	Seed Cotton	*Shelled Maize*
1 acre pure stand of each	1,370	847
2 acres interplanted	1,356	1,287
L.S.D. 5%	213	261
Coefficient of Variation	11.8%	18.7%

PLANT BREEDING

The work is still centred upon the Albar 51's and their derivatives, A637 producing the most promising material. It does not seem to be ideally suited for irrigation and selection within Albar for a more suitable type has not been successful. The breeding of a type suitable for irrigation continues, the variety U.P.A. (56) 5 introduced from Uganda, showing some desirable characteristics.

For the third consecutive year there has been a complete absence of bacterial blight on Makanga despite fully susceptible varieties being grown.

The prolonged rains caused excessive growth in all cotton, making picking a difficult task in some trials. A heavy attack of American Bollworm (*Heliothis armigera* Hbn) in late February caused damage to the late crop and all cotton was sprayed with D.D.T. Stainer (*Dysdercus* spp.) was prevalent later in the season resulting in a high percentage of grade 2 lint.

Owing to extension staff difficulties the Ngabu trials were abandoned.

Albar 51

A637 was grown throughout the protectorate. The heavy rains made conditions ideal for the development of bacterial blight but except for occasional leaf lesions there was no sign of any major infestation. As a result any fears as to the resistance of A637 to this disease have now been dispelled.

The variety shows considerable variation in the field but the Modal Bulk started this season should rectify this.

The best six selections from the Albar 51 strains were tested together with the four most promising Albar 51 crosses and the original varieties. The results were marred by the fact that the seed of A629 and A637 (57) 282 were damaged by excess acid during treatment and germination was very poor. The results are contradictory between the sites for all varieties except A637 (57) 136 and A637 (57) 158 which gave yields approaching that of the control at Makanga and showed an improvement on the control at Chitala. The results are given in Table VII.

TABLE VII

Cotton Variety Trial at two Sites

Makanga, sown December 16th *Chitala, December 5th*
5 replications at each site *Lint yields in lb. per acre*

Variety	*Makanga*	*Chitala*
C(50) 20	472	167
A618	444	175
A640	483	219
A629	166	175
A637	489	185
CLB..	429	186
347	475	201
282	238	136
246	425	223
158	457	215
262	414	228
136	487	214
524	438	212
519	431	231
515	433	192
510	413	176
SE	±50	±9

Albar Crosses

The fifty-four single plant selections taken from the Albar crosses made in 1957 were tested against related and introduced varieties. Twelve showed the required improvement upon A637 and have been retained for further testing. Their yields with those of the other varieties are shown in Table VIII.

TABLE VIII

Albar Crosses Trial

Makanga, sown December 16th

8 × 8 *Balanced Lattice* 9 *replications*

Lint yield in lb. per acre

Variety	*Yield*
211 (A637 × C(50)20)	647
127	545
227	614
491	585
493	580
513	573
173 (A637 × CL20)	558
161	551
693 (A640 × CL20)	531
672	559
61 (A629 × A618)	558
33 (A629 × CL20)	553
A640	617
A637	517
UPA (56) 5	515
A629	499
A(56) 22	499
A367 G	495
A618	473
A(56) 16	467
E54	461
ABC31	437
CLB	430
SE.	±14

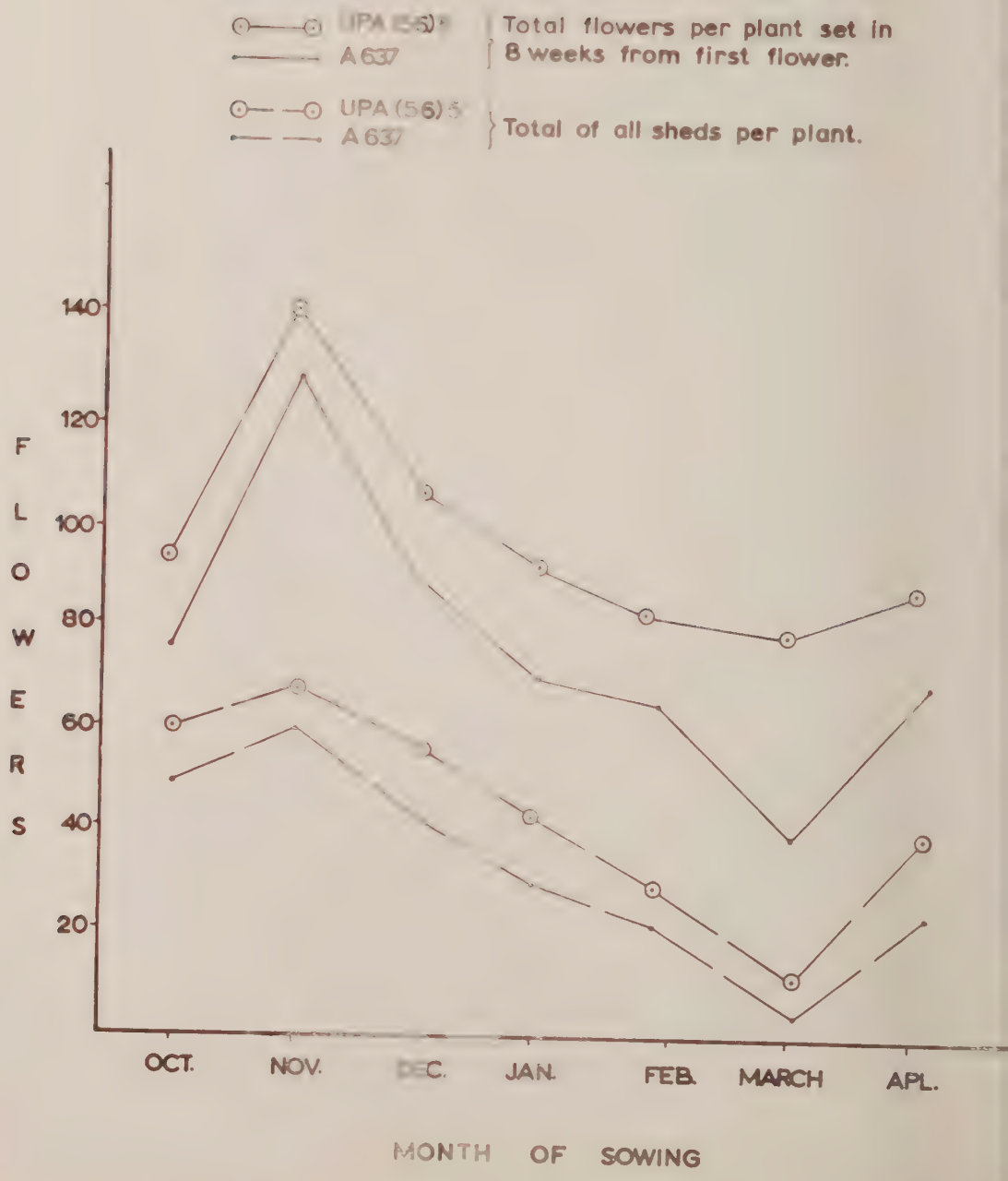
Time of Planting Observations

Owing to the close season for the control of Red bollworm (*Diparopsis castanea*) the planting of irrigated cotton in the past has been limited to that period. Plantings from October to late December here resulted in excessive vegetative growth producing plants with long internodes, little sympodial branching and a very high percentage of sheds. The crop has been carried on the top 4 ft. of the plants and yields have not been as high as could be expected. The picking and spraying of such a crop presented such problems that any large scale planting would be impracticable.

So that the problem could be more fully investigated, permission was obtained from the Ministry of Natural Resources and Surveys to plant cotton out of season providing it was sprayed against all insect pests. An observation plot was planted on the 30th of every month and consisted of one irrigation basin (1/32 acre) planted with three varieties, A637, E 54 and U.P.A. (56) 5. The white flowers of six plants of

FIGURE 1.

TOTAL FLOWER PRODUCTION AND ALL SHEDS OF IRRIGATED COTTON PLANTED AT MONTHLY INTERVALS



each variety tagged daily and any sheds collected daily. Plant spacing of 3 ft. by 1 ft. in the row, one plant per hill was uniform throughout. It was considered that an irrigated crop should be harvested within six and a half months to allow double cropping and therefore flower counts have only been analysed up to eight weeks first white flower. E 54 and U.P.A. (56) 5 were included as A637 has been criticized for its excessive vegetative growth, under irrigation.

It is appreciated that to confirm the findings similar work will have to be carried out over a number of years.

Figure 1 suggests that planting in November and December results in more bolls being retained per plant, with U.P.A. (56) 5 showing a higher potential than A637. The excessive height and vegetative growth (Table IX) however is the main limitation. The size of plant from January onwards reaches practical proportions and total bolls set per acre might be increased by a higher plant population. Work has been planned to investigate this during the coming season.

AGRONOMIC EXPERIMENTS AT MAKANGA

Varieties and Spraying Trial

Due to the investigations of the Cotton Pest Research Scheme, the spraying of cotton is becoming accepted practice especially in the Central Province. Jassid is a limiting factor to the use of many introduced varieties and since the spraying recommendations largely control this pest, six varieties were grown at two different sites to investigate the effects on variety yield. The main effects of spraying at Makanga show little improvement in yield over the unsprayed crop owing to excessive growth making spraying impossible at the critical time. The percentage of grade II cotton in the sprayed plots only showed an improvement of 2.6 per cent. over the unsprayed crop. This unusual effect was largely due to late stainer attack (*Dysdercus* spp.).

At Chitala the main effects of insecticide confirm the past work with an increase in yield statistically significant at the 5 per cent. level of probability. Spraying decreased the percentage grade II by 32.5 per cent. No variety has statistically outyielded A637 as a result of spraying but U.P.A. (56) 5 does show an improvement.

TABLE IX

Time of Planting Observation Plots

Mean plant heights in inches — *Two Varieties*

Month of planting	*Height*	
	A637	U.P.A. (56) 5
October	67	51
November	74	52
December	64	54
January	54	48
February	52	47
March	57	55
April	50	47
May	—	—
June	—	—

TABLE X

Trial of Varieties with and without Spraying at two sites
Yield of Seed Cotton in lb. per Acre

Makanga. Sown December 16th Split Plot 4 replications

Treatments	*Varieties*						
	A637	A (56) 22	F 22	CLB	U.P.A. (56)5	CL 20	Mean
Sprayed	1,405	1,045	980	1,093	1,383	1,143	1,175
Unsprayed	1,046	1,150	682	980	933	973	952
			SE. ± 90				SE. ±177
Mean	1,235	1,098	381	1,001	1,158	1,058	1,063
			SE ± 12 7				

Sprayed means	796	L.S.D. (P = .05)
Variety means	184	
Interaction	327	

Chitala. Sown December 6th Split Plot 4 replications

Treatments	*Varieties*						
	A637	A (56) 22	F 22	CLB	U P A (56)5	CL 20	Mean
Sprayed	421	399	370	356	425	367	390
Unsprayed	149	160	127	98	163	134	139
			SE ±15				±12
Mean	285	280	249	227	294	251	264
			SE ±21				

Sprayed means	57	L.S.D. (P –.05)
Variety means	44	
Interaction	79	

COTTON

Extract from Report of the Senior Agricultural Chemist

COTTON SEED OIL

The factory of Nyasaland Oil Industries has been given technical advice and assistance, although this has been asked for to a less extent than in previous years—possibly due to the fact that they have had the same laboratory assistant for a longer period than previously, and he has thus been able to utilize and develop fully the training he had been given.

Cake samples have shown that the standards, of 44 per cent. protein and 8 per cent. oil, have been maintained.

Two samples of poor seed were examined, and found very unsatisfactory. One from P.E.A. contained 33 per cent. bad seed, this seed giving only 13 per cent. of oil, which was of 26 per cent. F.F.A. content. The final acidity of the oil would be at least 8 per cent. with a refining loss of 25 per cent. The corresponding data on another sample from Chikwawa were 64 per cent. bad seed, containing only 10 per cent. of oil but with the same high F.F.A. content as found in the P.E.A. sample. The final acidity would, therefore, be at least 15 per cent., with a refining loss of 40 per cent. or more. It is of course emphasized that these are exceptional samples, and are only quoted to show how easily valuable seed can be ruined by inadequate storage and protection. Generally the bulk of the seed processed was sound.

COTTON

Extract from Report of the Entomologist

Populations of *Dysdercus* spp. (Cotton Stainer-bugs) were again small this season in all areas and nowhere did these insects achieve serious pest status in the period from November to April. Species of *Dysdercus* have not been of major pest importance since the 1955/56 season.

Cotton Jassid (*Empoasca fascialis*) was of less consequence this season than in the season 1960/61, although early attack was noticeable in a few of the drier areas. Later in the season, on maturing plants, jassid attack was somewhat more severe in general than in previous years, especially in the Lower River. Poor weeding in many gardens and lack of thinning were factors that helped to account for more severe late jassid damage.

Heliothis armigera (American Bollworm) was severe in most areas this season, and greater numbers were found in the Lower River than for the last five seasons. Serious damage was caused, notably at Chikwawa and near Ngabu, severe attacks developing in March and April. The pest was still present in some numbers in May and June. The trend over the past few years seems to indicate a general increase of damage by American Bollworm in cotton, and areas where previously only insignificant numbers were recorded were found with sometimes considerable numbers this season.

Numerous minor pests were more severe this season, due largely to lack of weeding and thinning in many gardens especially in the Lower River area. *Sylepta derogata* (Cotton Leaf-roller) was much more prevalent in the Lower River, for example, than has been the case for the past six years at least. *Cosmophila flava* (Cotton Semi-looper), *Plusia orichalcea*, *P. chalcites*, *Tarache nitidula*, *Xanthodes graellsii*, *Diacrisia investigatorum*, *Acrocercops bifasciata* (Cotton Leaf-miner) and *Argyroploce leucotreta* (False Codling Moth) were moths that were recorded in greater numbers than usual, although any severe or noticeable damage was normally confined to a few gardens or parts of a garden. *X. graellsii* larvae caused severe damage in a few places in February to the growing points and young bolls.

Coleopterous pests, more prevalent than usual in unweeded and unthinned gardens, were *Diplognatha gagates* v. *silicea* (Black Boll-beetle) and *Apion solcatum* (together with possibly other *Apion* spp.). *Apion* was particularly common in untended, newly opened gardens near Tomali in the Lower River. *Aphis gossypii* (Cotton Aphid) was much more prevalent in unweeded gardens.

Climatically, however, the season was an excellent one for cotton growing, and this, together with the considerably increased acreage this season, tended to mask the greater damage done by minor insect pests this season in badly cultivated gardens, since the overall yield was a record.

Pink Bollworm (*Platyedra gossypiella*) appeared for the first time since about 1942, and in June this year was discovered near Lake Malombe in considerable numbers. It was not recorded elsewhere in the country. It is probably largely due to the poor standard of field sanitation by some growers in the last few years that this pest has appeared again after an absence of some twenty years.

Cotton growers in Fort Johnston area were advised to uproot and burn the old cotton stalks immediately after picking, and to sweep up and burn the cotton trash in the fields. The seed-cotton from the infested area was transported to a central depot in Fort Johnston District and fumigated with methyl bromide. After fumigation, the seed-cotton was railed to Chiromo for ginning, and the cotton-seed was then sent to the oil extraction plant in Blantyre. None of the seed will be used for planting in the coming season.

The possibility of this pest appearing in other cotton-growing areas in Nyasaland next season cannot be ruled out, however, despite the precautions taken. A pamphlet entitled " Pink Bollworm of Cotton in Nyasaland " has been issued warning growers of this pest, and pointing out that the remedy is largely in the hands of the farmers themselves.

A series of illustrated booklets on cotton pests is being published which cover all the known insect pests of cotton in Nyasaland. The first of these was published in 1961 (Hemiptera. Bulletin No. 18, pp. 27, 14 figs.), the second in 1962 (Coleoptera. Bulletin No. 19, pp. 31, 32 figs.), while the third (Lepidoptera. Bulletin No. 20, pp. 39, 36 figs.) and the fourth and last (Other Orders Bulletin No. 21) are in the press.

COTTON PEST RESEARCH SCHEME
ANNUAL REPORT FOR THE 1961/62 SEASON

Introduction

There has been no change in the organization of the Scheme from the previous season. The main centres of experimental work have been Gatooma Research Station, Southern Rhodesia, Chitala Experiment Station, Nyasaland; and at Chikwawa, Nyasaland. Limited experimental work has been carried out at the Makanga Experiment Station and Sabi Valley Experiment Station.

Insecticide trials have been carried out at Mount Makulu Research Station and at Magoye Experiment Farm, Northern Rhodesia, with the co-operation of the Ministry of African Agriculture.

In May, 1962, Mr. D. J. McKinley joined the entomological team and he is now stationed in Nyasaland to help with the supervision of the work in that territory. Thus, with three entomologists, the Cotton Pest Research team is now up to full strength.

The lack of a third entomologist throughout most of the season, has necessitated frequent and prolonged visits to Nyasaland by the two entomologists to ensure adequate supervision of the experimental programme. Unfortunately, this has unavoidably resulted in a curtailment of the work at Gatooma, more especially in respect of toxicological studies, investigations into spray coverage and insect behaviour work. However, now that there is an entomologist stationed permanently in Nyasaland the more basic investigations at Gatooma should proceed without interruption.

The present Cotton Pest Research Scheme is due to terminate in June, 1963, but a proposal is being considered for an extension of the Scheme to June, 1965. This extension is highly desirable as there is every reason to believe that over the next two seasons there will be a considerable extension of commerical spraying of cotton in the Federation of Rhodesia and Nyasaland.

General

This season, one of the main projects has been again, a large-scale extension trial to assess the efficiency of insecticides in controlling cotton insect pests in the main cotton growing areas of the Federation, the results of which are reported. The Scheme is indebted to the advisory staff of the three territories for their valuable help and co-operation with our trials.

Dr. C. Cottrell is continuing his studies of diapause in *Diparopsis* at University College of Rhodesia and Nyasaland, and the Scheme has been able to co-operate in this work by supplying insect material.

A certain amount of advisory work has been undertaken by the Scheme in the form of instructional courses, published literature, and visual aids. Instructional courses on insect control have been held at the Chitala Experiment Station and at the Gatooma Research Station for advisory field staff and farmers. Two new 16 mm. films are in the process of being produced. One is a short film depicting the use of spray teams in Northern Rhodesia and of individual African farmers spraying their own cotton in Nyasaland. The other is a longer film showing all aspects of cotton growing and including industrial processing. This latter film is financed by the Rhodesian Cotton Growers' Association, and technical advice is being given by the Cotton Pest Research team.

An article giving the cotton insect control recommendations for 1962/63 in the Federation of Rhodesia and Nyasaland has been accepted for publication in the September/October issue of the *Rhodesia Agricultural Journal*.

In April, 1962, an extensive visit was made by Messrs. Tunstall and Matthews to the cotton growing areas of Northern Rhodesia at the invitation of the Ministry of African Agriculture. The visit was most informative, with the large scale use of spray teams for the spraying of African-grown cotton being of special interest.

Climate

GATOOMA

The 1961/62 season was affected by two periods of drought, one from the beginning of December until the end of the first week of January, and the other from the end of February. Planting rains in November were satisfactory (6 inches), enabling the crop to be sown during the second week of the month. Although the crop was well established, plant development suffered during the ensuing drought period. Total rainfall was 28 inches, of which 18 inches fell during the months of January and February. The lack of rain after the end of February (0.3 inches in March and 1.8 inches in April) severely affected the establishment of a top crop and yields suffered. Picking of the cotton crop commenced in May, and was completed on the Station by the end of June.

SABI VALLEY

Total rainfall was 24 inches, 12 inches of which fell in January, which tended to make controlled irrigation difficult. The remaining rainfall was fairly evenly distributed during the season. The cotton was sown during the middle of October and harvesting was completed by June.

CHITALA

The season was characterized by very good rainfall, a total of 43 inches being recorded. Distribution was adequate, with over five inches falling during each of the months from December to March inclusive. A total of 11 inches and 12 inches fell during December and January respectively. Three inches of rain fell during April enabling a good top crop to be set. The cotton was sown at the beginning of December, and picking commenced in May.

CHIKWAWA

Total rainfall at Chikwawa was over 30 inches, of which 14 inches fell during January. Three inches of rain during December allowed good germination of the crop sown at the beginning of the month. Good rains during April helped the setting of a top crop, and picking commenced during May.

Biological Investigations

A. THE FORMATION OF DIPAROPISIS OVERWINTERING PUPAE AND THE PERIOD OF SUBSEQUENT MOTH EMERGENCE

Experiments to determine the period of *Diparopsis* moth emergence from overwintering pupae were carried out at the Gatooma, Chitala and Makanga Experiment Stations and at Chikwawa. At Makanga, the method used was to make collections of 5th instar larvae contained within bolls at intervals during the season and to allow them to pupate in cages set in a pupation garden. The emerging moths were recorded daily. This method was also used at Gatooma and Chitala, but results were not satisfactory due to mortality and consequent low moth emergence.

At Gatooma, Chitala and Chikwawa, the period of moth emergence from overwintering pupae was determined by setting down field emergence cages on the previous season's cotton land which had been left fallow. It is felt that this method gives a more reliable assessment of the 'carry-over' moth flight. (*See* Annual Report for the 1960/61 season.)

At Gatooma, the period of moth emergence extended from November to March, with the main emergence occurring during December, January and February. 1.7 per cent. of the pupae remained alive in the soil at the end of the season. As in previous seasons, the emergence remained uniformly high over the period of the main emergence, with no pronounced peak over a short period.

The field emergence cages at Chitala gave essentially a similar pattern of emergence to the previous season, although fewer moths being recorded resulted in a more interrupted curve. The emergence began during November, and there was an indication of intensification of emergence during December. No emergence was recorded in January, and this was followed by the period of main emergence during February and March, which tailed off during April. 5.1 per cent. of the pupae remained alive in the soil at the end of the season.

The field emergence cages at Chikwawa showed an emergence period extending through February and March, tailing off in April. 1.3 per cent. of the pupae remained alive in the soil at the end of the season.

The experiment carried out under pupation garden conditions at Makanga showed a moth flight from overwintering pupae extending from August to April, with the period of main emergence during December and January. 1.9 per cent of the pupae remained alive in the soil at the end of the season. The emergence was generally little different from that of the previous season, apart from there being a rather more pronounced emergence during December. Larval collections were made during April, May, June, July and August, and for each of these months the proportion of larvae forming overwintering pupae was 29 per cent., 26 per cent., 51 per cent., 64 per cent., and 50 per cent. respectively. There was no observable difference in the subsequent periods of emergence for each larval collection period.

As in the previous season the emergence pattern of moths from overwintering pupae at Chitala and Makanga showed a distinct peak of emergence over a short period, in contrast to the emergence pattern at Gatooma. The number of moths was too low to indicate any peak emergence period at Chikwawa, but it is of interest that the period of emergence was generally later than at Makanga.

B. THE BEHAVIOUR RESPONSE OF DIPAROPSIS AND HELIOTHIS TO COTTON VARIETAL DIFFERENCES

During the season, preliminary work was carried out to assess the behaviour response of *Diparopsis* and *Heliothis* to various characteristics of Upland cotton, *Gossypium hirsutum*, especially the degree of pubescence. The behaviour responses

studied were oviposition, larval movement and the retention and larval uptake of insecticide deposits. This work is continuing and thus the following remarks can only be considered as a progress report.

The following strains of cotton were available for the tests:—

Strain	*Characteristics*	*Source*
Albar 637	Jassid resistance type pubescence	Commercial strain grown in the Federation
J Bulk	Dense pubescence ..	North Carolina State College
D2 Smooth (3 strns.) ..	Glabrous ..	,, ,, ,, ..
Nectaryless (293) ..	Nectaryless. Slight pubescence..	,, ,, ,, ..
MU8A	Jassid resistance type pubescence (More pubescent than Albar 637)	Gatooma Research Station

OVIPOSITION

For this work, mesh covered cages measuring 6 × 6 × 6 feet were used. The cages were sited in the open and were subjected to normal climatic conditions.

EXPERIMENT 1: Five female *Diparopsis* moths, emerged from pupae kept in the laboratory, were introduced into a cage containing one plant each of Albar 637, J. Bulk, D2 (Strain 717), Nectaryless and MU8A, and the eggs laid recorded the following day. This procedure was repeated on ten occasions over a period from the 9th to 24th February during which a total of 411 eggs were laid. On each occasion, a new batch of five moths was used, and the different plants were redistributed at random between the four corners and the centre of the cage. The plants used were grown in polythene pots, and at the time of the test bore buds, flowers and green bolls. The different varieties differed in growth, but, as far as possible, plants of equal size were used on any one occasion. An analysis of the results showed that there was no significant difference between the number of eggs laid on each of the cotton varieties, and thus there is no reason to suppose that *Diparopsis* will show a preference for either glabrous or pubescent varieties of cotton for oviposition. There was, however, a significant difference (P=0.05) between individual tests.

EXPERIMENT 2: The experimental technique described under Experiment 1, was also used for *Heliothis* moths. Only *Heliothis* moths known to have commenced egg laying were selected, and except on two occasions where moths caught in the field were used, the insect material was obtained from a laboratory culture. Six to nine moths were introduced into the cage on each of the ten occasions the test was carried out. A total of 1,398 eggs were laid over the period of the experiment from the 5th to 13th March. An analysis of the results showed that there was a highly significant difference (P=0.01) between the number of eggs laid on the different cotton varieties, results being as follows:—

Variety	J. Bulk	MU8A	Albar	293	D2 (717)
No. eggs laid ..	286	490	378	216	28

Least significant difference (P = 0.05) between treatments was 159 eggs. It is thus seen that when offered a choice, *Heliothis* moths show a distinct preference for the pubescent types of cotton, MU8A and Albar being the most favoured varieties. The fact that J Bulk was less favoured than MU8A, although much more pubescent could possibly be due to the pattern of pubescence, or of course, there may be other factors involved.

EXPERIMENTS 3 AND 4: In these experiments six *Heliothis* moths were introduced into a cage measuring 18 × 18 × 18 inches and given a choice of leaves from the same cotton varieties used in the above experiments. In one experiment only the upper surface of each leaf was presented, while in the other, the leaves of each variety were stood in tubes so that both sides were available for oviposition. Each test was replicated ten times, fresh moths and leaves (differently arranged) being used on each occasion. Results are given below.

Total number of eggs laid for each variety:

	Variety					
	J Bulk	MU8A	Albar	293	D2 (717)	LSD (P=0.05)
Upper surface of leaf	128	229	129	56	3	126
Both surfaces of leaf ..	149	358	176	104	9	111

It will be seen that the results are very similar to those obtained in Experiment 2.

EXPERIMENT 5: From the above experiments it is shown that ovipositing *Heliothis* show a distinct preference for certain strains of Upland cotton when given a choice. In this experiment, the same cotton varieties and technique as for Experiment 2 were used, with the exception that no choice was offered, each cage containing five plants of the same variety. The test, which was replicated ten times failed to reveal a significant difference between treatment varieties, although there was a tendency for the totals of eggs laid to fall into the same order as for the previous experiment.

No. of eggs laid with no choice of variety offered:

Variety				
J Bulk	MU8A	Albar	293	D2 (717)
367	565	268	379	167

LARVAL MOVEMENT

The movement of *Diparopsis* larvae from the time of egg hatch to penetration of a fruiting point on glabrous and pubescent cotton was compared, the two cotton varieties tested being D2 (717) and J Bulk. It was shown that the period of wandering was distinctly prolonged on J Bulk and it was noticeable that the larvae were confused by the hairs and the movement of the larvae tended to be intermittent. Furthermore, there were more successful penetrations on the glabrous variety, many larvae dying on the hairy J Bulk before reaching a fruiting point.

RETENTION AND LARVAL UPTAKE OF INSECTICIDES

There was found to be little difference between J Bulk and D2 (717) in respect of mortality from egg hatch to penetration of a fruiting point on plants sprayed with 'Sevin' the day before being infested, satisfactory kills being obtained in both cases. However, when the plants received one inch of rainfall three hours after spraying, the retention of insecticide deposits was greatest on the J Bulk, as indicated by the higher mortality of larvae on this variety compared with the glabrous D2 (717).

From the above experiments, there are strong indications that the insecticide control of *Diparopsis* may be more effective on pubescent rather than on glabrous varieties of cotton, as a result of increased retention of insecticide deposits under rainfall and prolonged movement of the first instar larva. There appears to be little or no difference between the number of eggs laid on the different varieties tested by *Diparopsis* and by *Heliothis* when no choice is offered, but further studies are required on this point before any definite conclusions can be reached.

C. THE REARING OF COTTON INSECTS FOR LABORATORY WORK

Cultures of *Diparopsis*, *Heliothis* and *Dysdercus* spp. have been maintained during the season at Gatooma at a sufficiently high level to provide material for toxicological work and small scale behaviour experiments. Cultures of *Earias* spp. and *Phonoctonus nigrofasciatus* have also been maintained.

In culturing *Diparopsis*, improved egg viability has resulted from allowing female moths to emerge from pupae in the presence of male moths. It is believed from previous behaviour studies in the field, although verification is required under laboratory conditions, that the female moth requires to be mated immediately following emergence. The practice now is to leave the male moths in the emergence cage, taking out the females daily and placing them singly in oviposition cages.

In the past difficulty has been expressed in transferring the young *Diparopsis* larvae from the initial bud or boll to a second boll after the first few days, and considerable mortality has resulted. This has now been overcome by transferring each larva to one of the halves of a gelatine capsule, size 0, and pinning the open end of the half capsule to the boll wall. In this way penetration readily occurs, but the capsule has to be left in the light, as otherwise the larvae tend to eat through the gelatine wall.

In the rearing of *Earias*, improved results have been obtained from feeding the larvae on ornamental *Hibiscus* buds rather than on cotton buds and bolls.

Difficulty with rearing *Dysdercus* was experienced when the humidity control failed to operate. The majority of the adult stainers had deformed wings and failed to copulate.

Chemical Control of Diparopsis and Other Insect Pests of Cotton

A. LABORATORY TOXICITY TESTS

(i) *Diparopsis egg dipping*

Two carbamate insecticides—Bayer 5024 and ' Zectran ' have been shown to be as toxic to *Diparopsis* as ' Sevin '. The LC 50 for the egg dipping technique (*see* Annual Report for 1960/61) has been determined as 0.002 per cent. and 0.005 per cent. respectively.

(ii) *Heliothis*

By ' painting ' young larvae with various concentrations of insecticides and allowing them to feed on a fresh *Dolichos* flower for 24 hours, several more insecticides have been tested and LC 50's determined as follows:—

			per cent.	
endrin	20 EC	..	0.002	
D.D.T.	25 EC	..	0.0043	different formulations
D.D.T.	25 EC	..	0.0046	different formulations
D.D.T.	50 W	..	0.0059	
' Thiodan '	35 EC	..	0.0176	
' Sevin '	85 S	..	0.0338	
5024 ..	50 W	..	0.0246	
' Zectran '	24 EC	..	0.0039	

EC = emulsifiable concentrate W = wettable powder S = sprayable powder.

(iii) *Dysdercus*

Adult stainers were caged for 24 hours over large green bolls dipped into various concentrations of insecticide. The LC 50's for *Dysdercus intermedius* and *D. fasciatus* are given in the following table:—

Insecticide	*Dysdercus intermedius*	*Dysdercus fasciatus*
'Sevin' 85S	0.0373 per cent.	0.0103 per cent.
5024 50 W	0.0274 per cent.	*
Endrin 20 EC	0.155 per cent.	0.0702 per cent.
D.D.T. 25 EC	0.342 per cent.	0.213 per cent.
'Thiodan' 35 EC	0.735 per cent.	*

*not tested.

(iv) *Wandering of 1st instar larvae (Diparopsis)*

A few tests using 'continuous observation bioassay' were carried out to assess the behaviour and period of wandering of 1st instar larvae from time of egg hatching to death or penetration of a bud or boll, on plants subjected to different amounts of rainfall. The plants were about seven weeks old and growing actively following the formation of first buds.

When rain fell some three hours after the spray had dried on the plants, the period of wandering increased with the increasing amount of rain. For eggs placed on the upper surface of leaves the larval wandering period increased to a level of about three times that on a fresh spray deposit after $\frac{1}{2}$ inch of rain. The increase in wandering time was less marked for larvae hatching from eggs placed on the stem.

If rain falls seven days after spray application, the larvae wander for very long periods even with very small amounts of rain (0.05") but this is partly explained by the growth factor, which exerts a considerable effect on persistence even when the spray deposits are exposed to laboratory conditions.

For the present, it is thought advisable to respray crops only if over half an inch falls immediately after spraying. The interval between sprays should be reduced slightly to five or six days if heavy rain occurs over a period of days following a spray application.

The effect of rainfall is reduced when the plants are larger and more dense when the foliage shields much of the plants' framework from the action of the rain. It is for this reason that it is important to spray 'up and under' the plants so that as much spray as possible penetrates the inner framework of the plants.

B. SPRAY COVERAGE ASSESSMENTS

Some spray coverage assessments were carried out at Chitala Experiment Station, using croceine scarlet spray solution and table tennis balls as targets (*see* Annual Report 1959/60).

It was shown that with cotton four feet high (on one of the extension trial plots) that a knapsack sprayer with tailboom gave more even cover and a higher mean deposit than a simple 'Plantector' sprayer. In an effort to get good cover with the 'Plantector' the nozzle was moved up and down while the operator walked slowly between the rows.

There was no significant difference in the coverage of cotton at single plant spacing compared with three plants per hole, using a tailboom. The plants of the single plant spacing had more buds and bolls whereas the framework of plants in plant holes was more open.

C. FIELD INSECTICIDE TRIALS

(i) *Insecticide Trial*

A field trial to assess the timing and relative effectiveness of 'Sevin', D.D.T. and 'Thiodan' sprays was carried out at Gatooma, Chitala, Mount Makulu and Magoye. Yield results for the four centres are given in Table I. Each insecticide was applied at 0.5 per cent. active ingredient in 5–30 gallons of spray per acre, depending on growth. The 'blanket' treatment involved 'Sevin' and D.D.T. or 'Thiodan' sprays at weekly intervals from first bolls to start of harvesting or more frequently during periods of wet weather. All sprays were applied with a knapsack sprayer fitted with a tailboom. The dust treatment in the Chitala trial was applied by means of a Kestral duster.

Certain entomological and plant growth records were taken on all trials. A summary of egg and larval counts is given in Table II. No pink bollworm was recorded on the Northern Rhodesia plots, although this insect has been recorded in certain parts of the territory. American bollworm (*Heliothis armigera*) was the major pest on all trials. D.D.T. and 'Thiodan' controlled this insect satisfactorily, whereas 'Sevin' did not give adequate control. At Gatooma the *Heliothis* attack persisted through a period of drought, during which 'Sevin' appeared to give better control than during the wet weather.

Earias was of some importance in the Magoye region, but all treatments gave satisfactory control.

Taylorilygus simonyi also occurred at Mount Makulu but detailed records were not taken.

With the introduction of scouting the crop to assess the status of the bollworms and crop potential, the degree of insect control has been considerably improved resulting in yields well in excess of 1000 lb. seed cotton per acre under raingrown conditions. It should be remembered that the relatively high yields obtained on the unsprayed plots is due to the interaction between plots. In particular jassid was controlled very effectively on the unsprayed plots.

TABLE I

Yields lb. Seed Cotton per acre. *% damaged cotton given in brackets*

Treatment	*Locality of trial*			
	Gatooma S.R.	*Chitala Nyasaland*	*Magoye N.R.*	*Mt. Makulu N.R.*
1. Unsprayed	866 (4)	1,304 (11)	1,125 (22)	1,094 (8)
2. 'Blanket' treatment	2,132 (1)	2,471 (2)	1,739 (5)	1,402 (4)
3. Weekly sprays 'Sevin' *changes to D.D.T. (official recommendation)	1,811 (1)	2,090 (2)	2,149 (5)	1,500 (2)
4. Weekly sprays 'Sevin' with changes* to 'Thiodan'	2,061 (1)	2,167 (2)	1,901 (6)	1,306 (5)
5. Weekly sprays 'Thiodan'	2,134 (1)	2,451 (2)	1,924 (6)	1,742 (2)
6. Weekly sprays 'Sevin'	2,013 (1)	1,899 (3)	1,919 (4)	1,498 (3)
7. Weekly sprays D.D.T.	1,696 (1)	2,240 (3)	1,885 (7)	1,320 (3)
8. As in Tr. 3 but fortnightly with sprays repeated after rain	1,913 (1)	2,056 (3)	1,868 (7)	1,228 (6)
9. Weekly 'Sevin' dust (5%)	—	1,959 (2)	—	—
CV %	15.9	11.5	18.4	19.2
LSD 5%	414	348	493	376

* Changes specifically for *Heliothis* control. Rogor added for aphid control when necessary except Treatments 4, 5 and 9.

(ii) *Tractor spraying trial*

A trial on a six and a half acre field was carried out to assess the efficiency and practicability of using a tractor-mounted sprayer for spraying cotton. In order to avoid damage to the cotton caused by the passage of the tractor, a system of strip cropping was practised in which seven rows of cotton alternated with three rows of groundnuts (variety Valencia), the groundnuts taking the place of two rows of cotton. Both crops were grown on the flat. The cotton was sown by machine in three foot rows, which were subsequently thinned to nine inches between single plants. The groundnuts were hand sown in three rows 18 inches apart. This allowed sufficient space for the wheels of the tractor to run between the outside rows of the cotton and groundnuts. The height of the groundnuts was sufficiently low to give free passage for the Ferguson T.F. 20 tractor. The total acreage of cotton and groundnuts was 5.08 and 1.42 acres respectively.

The sprayer consisted of a 40 gallon tank fitted with a ½ inch gear pump driven by the power take off of the tractor. A special spray boom was used to provide suspension of seven tailbooms, which enabled 3½ rows on each side of the tractor to be sprayed. The tailbooms were similar in design to those fitted to knapsack sprayers (*see* Annual Report for 1959/60 season), except for the addition of a flexible foot. This consisted of an additional foot length of vertical boom attached to the lower end of the original boom by means of a piece of rubber hose, the flexibility of which prevented damage to the boom when in contact with the ground. The lower pair of nozzles was carried on the extension piece. When the cotton became large it was found necessary to fit light aluminium guards to each tailboom. Tractor wheel guards were not fitted, although they would be required for particularly dense cotton.

A total of 14 sprays were applied according to the published recommendations (Tunstall and Matthews, 1961) and included six 'Sevin' sprays and eight D.D.T. sprays, giving a total of 197 gallons of spray per acre. Rogor was added to four of the spray applications for aphid control. One spray, during wet weather, was applied by knapsack sprayer, although later this was considered unnecessary, as the tractor could have been on the land a few hours later. Plant growth was satisfactory throughout the field, the cotton plants at the end of March having an average of 128 sympodial nodes and 31 green bolls per plant, with an average height of 49 inches per plant. Stand was 97 per cent. of the theoretical value. The groundnuts grew fairly well and were not unduly affected by the adjacent cotton.

Insect attack, especially of American bollworm, was high, the nature of which was similar to that given under the Large Scale Extension Trial (*see* below).

In taking yields, the inside and outside rows of cotton bordering the groundnuts were considered separately to obtain a measure of any growth compensation in respect of the latter. Yield results for the cotton and groundnuts are given in the following table:—

Tractor Spraying Trial

YIELD DATA

Total cotton area	..	..	.. 5.08 acres
Total groundnut area	..	..	.. 1.42 acres
Length of strips	..	..	.. 1445 feet

Yield in lb. of seed cotton and shelled nuts per acre based on

Total cotton acreage	*Outside cotton rows*	*Inside cotton rows*	*% damaged cotton*	*Total Groungnuts acreage*
2,555	3,020	2,375	0.07	685

TABLE II

Spraying Trials 1961–62

G — Gatooma

Treatment	Mean No. eggs per plant					
	Diparopsis			*Heliothis*		
	G	C	M	G	C	M
Unsprayed	2.42	2.58	—	18.3	16.3	1.27
' Blanket '	0.60	2.83	—	31.5	12.8	0.88
Weekly ' Sevin ' with changes to D.D.T.	1.27	2.33	—	28.6	13.5	1.43
Weekly ' Sevin ' with changes to ' Thiodan '	1.78	1.17	—	31.4	14.6	1.33
Weekly ' Thiodan '	1.15	1.67	—	33.9	10.3	1.55
Weekly ' Sevin '	1.38	2.33	—	31.3	14.4	1.43
Weekly D.D.T.	1.98	2.33	—	28.0	10.3	1.50
Rainfall	1.18	2.17	—	24.1	16.8	0.95
' Sevin ' 5% dust	—	1.50	—	—	11.6	—
L.S.D. 5%	n.s.	n.s.	—	5.6	n.s.	n.s.

Spraying Trials 1961–62

C — Chitala *M — Magoye*

Treatment	Mean no. larvae per plant								
	Diparopsis			*Heliothis*		*Earias*			
	G	C	M	G	C	M	G	C	M
Unsprayed	0.42	0.17	—	5.50	1.83	4.00	0.50	—	0.67
' Blanket '	—	—	—	0.35	—	0.67	0.17	—	0.25
Weekly ' Sevin ' with changes to D.D.T. ..	0.75	0.33		0.75	0.58	0.50	—	—	0.25
Weekly ' Sevin ' with changes to ' Thiodan ' ..	0.17	—	—	0.33	0.58	0.83	0.25	0.08	0.17
Weekly ' Thiodan ' ..	0.33	0.08		0.33	0.08	0.83	0.08		
Weekly ' Sevin ' ..	1.08	0.17		3.67	2.83	2.25	0.08	0.17	0.42
Weekly D.D.T.	0.75	0.50	—	0.58	0.33	0.25	0.08	0.08	0.25
Rainfall	0.25	0.58	—	1.58	1.17	0.75	0.17	0.17	0.25
' Sevin ' 5% dust ..	—	0.08	—	—	1.33	—	—	—	—
L.S.D. 5%	0.49	n.s.	—	1.57	0.17	0.42	n.s.	n.s.	n.s.

It will be seen that the overall yield of cotton was satisfactory, although that for groundnuts was poor. The rows of cotton bordering the groundnuts gave a considerably higher yield than the inside rows, and compensated for the two absent rows to the extent of 27 per cent. for the length of strips and acreage of field under consideration.

The groundnuts at 90s a 180 lb. bag and the cotton at 8½d. per lb. gave a good gross return per acre of £73. With production costs estimated at £27 per acre, a net return of £46 per acre was obtained, inclusive of the two crops.

In an adjacent field, maize yielded 11.9 bags to the acre giving a gross return of £15–10s. per acre. (26s per 200 lb. bag.) With production costs estimated at £16 per acre, there was a net loss of 10s per acre.

The experiment clearly showed that tractor spraying was a practical proposition under the climatic conditions encountered at the Gatooma Research Station during the 1954/55 season. The crop regularly presented only slight plant damage caused by the passage of the tractor, and the guarded tailboom passed between the rows of cotton satisfactorily.

(iii) *The effect of various additives in the persistence of 'Sevin' sprays*

'Lovo' 190 and 'Glyodin' were tested to determine whether their addition to 'Sevin' sprays would improve insect control, particularly during wet weather. Owing to the drought periods the treatments were not subjected to prolonged wet weather and no significant differences between yields were obtained.

(iv) *The performance of three D.D.T. formulations*

Three emulsifiable concentrate formulations were sprayed on to small unreplicated plots at Gatooma. No phytotoxic damage was observed and yields of over 1500 lb. seed cotton per acre were obtained from all three plots.

(v) *Comparison of certain aphicides*

Dimethoate, malathion, menazon, 'Ekatin' and 'Lebaycid' were applied with a tailboom to cotton which had not been previously sprayed, and on which an aphid infestation was already established. Heavy rain fell shortly after spraying and a total of 5" fell during the next five days. Only dimethoate and menazon gave satisfactory control of the aphids.

(vi) *The control of an established infestation of Diparopsis*

Although 'Sevin' applied regularly will give excellent control of *Diparopsis* it was not known to what extent an established population could be controlled. A plot of cotton in the Salima Lake-shore area was selected and 'Sevin' applied with a tailboom at 0.5 per cent. a.i. using Y3 nozzles (approx. 20 gallons per acre) and Y6 nozzles (approx. 50 gallons per acre) and at 2.0 per cent. a.i. using Y3 and Y6 nozzles. Thus 1, 2, 4 and 8 lb. 'Sevin' a.i. per acre were applied. The lowest rate was equivalent to the recommendations for cotton about 3 feet in height. The treatments were to have been repeated on half the plots after heavy rain, but as no rain fell for two weeks following the sprays, each treatment was in fact replicated eight times.

The results of examination of damaged buds and bolls is given in Table III. It will be seen that owing to the small plot size (1/120th acre) the population of larvae, [illegible] was also reduced on the unsprayed plots. After the second post-[illegible] counts [illegible] rain fell and the *Diparopsis* larval population increased on all plots.

As the plot size was small, the lowest application rate was compared with unsprayed without replication on a larger garden. The spraying was repeated after the first rain and when larval populations were beginning to rise. Larval counts are given in Table IV. 'Sevin' at 0.5 per cent. reduces the infestation, particularly of the 1st and 2nd instars but with new growth and wet weather, sprays have to be repeated to maintain control.

Unfortunately the grower picked some of the cotton so that final yields could not be obtained. However from visual observations it was clear that the two spray applications had increased the yield.

D. THE EXTENSION TRIAL

A second [illegible] extension trial was carried out in Nyasaland and S. Rhodesia to assess the [illegible] of insecticides in controlling cotton insect pests, the differences in response between the main cotton producing areas and to determine whether seed cotton and lint quality characters were affected by controlling the pests.

The design, cultural treatment and recording of the plots was essentially the same as in 1960/61 (*see* previous Annual Report). The sprayed subplots were sprayed according to the published recommendations (Umstall and Matthews, 1961).

All plots were scouted regularly and detailed records of plant growth and insect populations were taken on selected plots.

Jassid (*Empoasca fascialis*) occurred extensively on all plots especially during January and early February after which populations declined naturally. Immediate control was obtained on all the sprayed subplots following the first application.

Red bollworm occurred throughout the areas of the trial, but was most serious in the Salima Lake-shore. The major pest was American bollworm which was only controlled effectively by the changeover to D.D.T. when indicated by the results of 'scouting'. American bollworm was particularly severe in the Gatooma area from early January to April with the main peak in March.

TABLE III

Shock Spray Treatment Trial

Diparopsis larvae on 24 plant holes per treatment (= 72 plants)

	Sampling date	27–2–62						3–3–62					
	Instar	I	II	III	IV	V	Total	I	II	III	IV	V	Total
Treatment	Unsprayed	3	40	20	9	1	73		14	12	8	11	45
	0.5% 'Sevin' Y3 nozzle	7	30	15	13	2	67		2	6	3	6	17
	0.5% 'Sevin' Y6 nozzle	4	36	20	6	9	75		1	3	2	3	9
	2.0% 'Sevin' Y3 nozzle	8	32	18	6	10	74		1	6		3	10
	2.0% 'Sevin' Y6 nozzle	11	27	18	6	6	68			1			1
	TOTALS	33	165	91	40	28	357	—	18	28	13	23	82

Sprays applied after count on 27–2–62
Rain fell 12–3–62, 17–3–62 and 18–3–62—1.27, 1.25, and 0.10 ins. respectively.

	Sampling date	10–3–62						3–4–62					
	Instar	I	II	III	IV	V	Total	I	II	III	IV	V	Total
	Unsprayed	1	11	10	9	13	44	2	13	7	7	5	34
Treatment	0.5% 'Sevin' Y3 nozzle		1		1	12	14	14	17	10	4	9	54
	0.5% 'Sevin' Y6 nozzle	1			1	1	3	12	11	16	5	6	50
	2.0% 'Sevin' Y3 nozzle						—	12	14	11	4	11	52
	2.0% 'Sevin' Y6 nozzle		1				1	4	18	4	6	8	40
	TOTALS	2	13	10	11	26	62	44	73	48	26	39	230

The yield data (Table V) showed an overall average increase of 848 pounds of seed cotton per acre from 40 plots. The one negative result in Nyasaland was partly the result of agronomic factors and partly poor control of American bollworm while that in S. Rhodesia was in an area isolated from cotton. The largest yield differences were obtained in the middle veld of S. Rhodesia where American bollworm, aphid and jassid all caused considerable crop loss on the unsprayed subplots. The percentage damaged seed cotton was greatly reduced on the sprayed plots.

TABLE IV

Heliothis larvae on 12 plant holes per treatment (36 plants) Bikael's garden, Pemba, Salima

Treatment	*Sprayed*						*Unsprayed*					
	Instar						*Instar*					
Sampling date	I	II	III	IV	V	*Total*	I	II	III	IV	V	*Total*
28–2–62	1	11	10	7	9	38	1	16	14	7	7	45
3–3–62				4	6	10		6	7	4	8	25
6–3–62	1	2	3	1	2	9	6	14	9	9	8	46
10–3–62	2	1				3	5	12	7	4	13	41
13–3–62	4	11	6	2		23		1	9	11	20	41
17–3–62		3			1	4		7	6	2	7	22

Sprayed following count on 28-2-62 and 13–3–62
Rain 12-3-62 = 1.27″

E. THE DEVELOPMENT OF SPRAYING EQUIPMENT

(i) *Knapsack Sprayers*

Slight modifications have been made to the Mysto K/GS/sprayer by the manufacturers, principally in a strengthening of construction. The tailboom has been adapted to carry eight instead of six nozzles. The extra cost involved is small compared to the increased spray coverage, especially in tall cotton, and the higher degree of output regulation obtained. Fitted with eight Spraying System's Y3 Cone-Jet spray tips, the tailboom will deliver from 5 to 30 gallons per acre satisfactorily.

(ii) *Tractor-Mounted Sprayers*

A tractor-mounted sprayer carrying a rig fitted with nine tailbooms has been developed. The normal tailboom as fitted to a knapsack sprayer is used, with the addition of a flexible foot on which the bottom pair of nozzles is attached and a lightweight aluminium crop guard. A Ferguson tractor is being fitted with crop guards, both for the wheels and the underneath of the tractor, and next season this will be tested with uniform cropping and an assessment made of any damage to the crop.

TABLE V

Yield Data for Extension Trial Plots 1961–62

Yields based on whole sub plot. Mean area = 0.5 acre

	Plot No.	Yield (lb. s.c./acre)			% damaged cotton	
		Sprayed	Unsprayed	Increase	Sprayed	Unsprayed
NYASALAND						
Southern Province ..	1	1,206	696	510	13.5	36.0
	2	1,156	544	612	19.5	33.2
	3	1,480	836	644	21.9	27.4
	4	1,199	791	408	5.4	18.4
	5	1,567	890	667	2.2	14.8
	6	1,978	526	1,452	13.1	35.1
	7	1,365	695	670	11.1	34.0
	8	1,524	463	1,061	5.6	25.2
	9	1,180	494	686	5.1	15.9
	10	1,175	319	856	9.4	53.2
	11	273	490	−217	44.8	67.7
	12	1,928	709	1,219	17.0	31.6
	13	1,055	844	211	18.8	19.1
	14	1,073	393	680	15.7	39.5
	15	858	472	386	22.0	35.7
	16	913	266	647	35.6	50.5
	17	717	201	516	31.8	53.1
	18	1,904	619	1,285	8.2	14.3
	19	1,290	292	998	4.8	21.5
	20	616	16	600	8.6	36.4
Mean ..	—	1,046	431	615	11.5	36.3
Central Province ..	21	1,838	1,049	788	4.5	11.5
	22	1,798	581	1,217	6.8	24.5
	23	1,296	465	831	4.1	24.5
	24	1,420	125	1,295	8.1	44.7
	25	633	461	172	11.7	7.9
	26	833	91	742	2.4	21.4
	27	1,249	428	821	7.1	28.2
	28	1,090	189	901	16.5	33.5
	29	1,939	755	1,184	3.1	27.4
	30	1,704	647	1,057	3.8	23.9
	31	592	241	351	3.2	2.3
	32	1,329	874	445	0.1	13.2
Mean ..	—	1,407	648	759	4.0	20.3
S. RHODESIA						
Low Veld	33*	1,442	1,602	−160	16.9	18.2
	34*	2,212	1,596	616	6.1	45.9
	35*	583	134	449	35.1	55.6
Mean ..	—	1,205	1,024	181	16.4	37.2
Middle Veld	36	2,452	309	2,143	0.1	21.0
	37	1,836	208	1,628	0.6	6.9
	38	1,723	319	1,404	0.3	15.9
	39	1,511	823	688	1.1	9.0
	40**	2,196	1,247	949	2.2	9.6
Mean ..	—	1,941	517	1,424	0.9	11.6
Overall Mean ..	—	1,396	548	848	6.1	26.8

*=Irrigated **=Supplementary irrigation

NOTE: Means weighted according to acreage of plots.

(iii) *High Clearance Sprayers*

A high clearance sprayer carrying a rig fitted with five or nine tailbooms which can be either self propelled or drawn by draught animals (oxen, mules, etc.) is being developed. The spray pump is provided by means of a small four-stroke engine, fitted to the frame of the sprayer.

(iv) *Portable-line system of spraying*

The portable-line system of spraying is being investigated as a means of spraying cotton. The system consists of having a line of several spray operators, each of whom carries a tailboom attached to a lightweight shoulder harness. Each tailboom is supplied by means of PVC hosing, linked between each operator, the tailboom of the operator at one end being connected to the spray pump.

Two methods of working the system are possible. The first consists of having the line of operators in adjacent rows, the supply being run out behind them from a stationary spray pump. When the spray operators reach the limit of the hose which may be up to 150 yards in length, they return down an adjacent set of rows, the hose being wound in. Handlers for the hose line are required to keep it from interfering with the movement of the spray operators. The spray pump is moved to new positions as required.

In the second method the spray operators are separated by ten or more rows, the interlinking hose being held above the cotton by means of a light pole held in a waist socket attached to the harness of each spray operator. The tailboom of the first operator of the line is supplied by a hose similar to the interlinking hose, direct from the spray pump which is tractor or trailer mounted. As the line of operators move through the field the tractor keeps pace with them travelling along a path alongside the field. At each turn the spray operators move across one row, the tractor driver paying out the extra hosing needed. With this method, the hose is evenly distributed between each operator, and there is no need for line handlers. However a pressure regulator must be fitted to each tailboom.

The portable line may be used as an alternative method to knapsack or tractor sprayer, and with suitable organization could be used in many systems of agriculture.

Alternatively it would be of value in supplementing tractor spraying when the ground is too wet to allow passage of a tractor. The method has also been found useful in Natal, S. Africa, where the land is too steep and hilly to permit spraying by tractor.

F. THE COMMERCIAL APPLICATION OF COTTON INSECT CONTROL

As a natural expansion from the extension trial carried out in Nyasaland during 1960/61, a limited number of progressive farmers were allowed to spray their own cotton under the supervision of the local Agricultural Supervisor. In the Salima district, the farmers were allowed to spray their entire acreage but in the Chiromo district, not covered by the extension trial, the selected farmers were advised to spray only half their cotton. In Table VI, the yield per acre and estimated profit per acre is given. In deriving the estimated profit the insecticide has been costed at current retail prices, the cost of the sprayer over six acre-years, and general growing and picking costs at approximately £12 per acre, weighted according to the amount of picking involved. In assessing the profit it should be remembered that the costings include all labour costs, even though the farmer may have carried out most of the work himself.

On average, farmers can expect to make a profit of approximately £12 per acre compared with £6 per acre or less on unsprayed cotton. However, this level of profit can only be achieved if the agronomic factors for the crop are not limiting. The farmer Kaludzu made a slight loss because nearly 50 per cent. of his field was severely waterlogged which resulted in poor plants that could not be sprayed regularly during the wet weather.

Expansion of agronomy experiments on a district basis is essential if more cotton is to be sprayed to the fullest economic advantage.

Spraying of African-grown cotton has increased considerably in Northern Rhodesia where spraying so far has been by 'spray teams' covering between 15–25 acres depending on the distribution of African farmers in the area. Yields have been variable due to some extent to certain spraying and agronomic factors, but the mean yield from over 150 acres was in excess of 800 lb. per acre. With costs rather less than those used in Table VI as a result of bulk purchase of insecticide and the sprayer costed over 45 acre-years, the majority of farmers made large profits. A further large expansion in cotton acreage is planned for the 1962–63 season, during which some farmers will be encouraged to spray their own cotton rather than rely on the spray teams.

TABLE VI

Costings on Progressive Farmer Cotton

District	Farmer	Area in Acres	Treatment	Yield lb. seed cotton per acre		Value of Cotton per acre	Profit per acre
				Grade I	Grade II		
Salima	Esau ..	1.5	S	1,621	83	899s	401s
	Bevoti ..	1.5	S	2,175	102	1,204s	602s
	Kundai ..	1.9	S	1,068	—	579s	156s
	Kaludzu ..	1.8	S	601	6	327s	—33s
	Mbabzi ..	1.0	S	1,275	100	716s	239s
	Mean ..	1.5	S	1,309	30	722s	257s
Chiromo	Khasu ..	0.91	S	1,394	125	786s	258s
		0.91	U	447	141	277s	72s
	Khasu ..	0.15	S	1,393	240	815s	201s
		0.15	U	473	253	320s	100s
	Meke ..	0.5	S	1,366	310	817s	302s
		0.5	U	826	456	561s	273s
	Gundani ..	1.44	S	883	146	515s	97s
		1.44	U	315	231	228s	30s
	Mean ..	0.75	S	1,259	205	733s	234s
		0.75	U	515	270	347s	121s

S = sprayed U = unsprayed

The spraying of cotton on African farms on irrigation schemes in the Sabi Valley area of Southern Rhodesia has continued with yields of generally over 2000 lb. seed cotton per acre being obtained. The Co-operatives are, however, gradually taking over the spraying operations from the Department of Agriculture.

A large expansion in cotton acreage is also forecast for European farmers in Southern Rhodesia as a result of the high yields obtained as a result of spraying.

G. AGRONOMY TRIALS

Further experiments to assess spacing, fertilizer and other agronomic practices for sprayed cotton were carried out at Chitala and are reported by the Agronomist, Chitedze Research Station.

In order to maintain insect pest control, it is essential to maintain a regular spray programme. However, periods of heavy rain will interrupt such a programme and it has been found that it is necessary to have sufficient equipment to spray the entire acreage of a farm in no more than three days of any one week.

It has been demonstrated that the level of yield of seed cotton per acre and percentage of clean cotton influences the rate of picking. At Gatooma in a field with approximately 1000 lb. seed cotton per acre ready to pick, very little of which was damaged, pickers could reap an average of 74.9 lb. per day (based on 24 women working for 3 days). In contrast on unsprayed cotton with a yield level of 208 lb. per acre much of which was damaged, the same pickers averaged 31.9 lb. per day. In this experiment the pickers received 0.75d per lb. of seed cotton picked.

I. DISCUSSION

The results of trials carried out during the 1961-62 season have confirmed the tentative conclusions reached at the end of the previous season. Namely the main cotton insect pests can be controlled in all the cotton growing areas in the Federation by using insecticides, and that the economic return from this method depends on the correct application and timing of the appropriate insecticide for the various pests on crops with a high potential yield. Any criticism that this conclusion is based on 'special' plots, i.e. agricultural instructors' gardens, and is thus not valid as far as the grower is concerned, can be dispelled by the results obtained by progressive farmers spraying their own cotton. The success of these farmers should be judged by the desire of other progressive farmers in the same locality to spray their cotton. At present emphasis will be restricted to a gradual expansion of chemical control by individual farmers who, having obtained the necessary equipment at a subsidised price, will be prepared to look after their crops.

However, other means of spraying growers' cotton are being investigated to determine whether suitable methods can be adapted for co-operative use either by farmers' associations or in collaboration with the proposed community development schemes.

Progress has been made in the study of certain plant characters on the behaviour and natural mortality of the bollworms. Results from this study however can only be expected to modify a spray programme, and will not provide an alternative means of control.

J. SUMMARY

High yields of seed cotton were obtained from sprayed cotton in all areas of the Federation despite the variations in the amount and distribution of rainfall and other climatic factors.

Studies on the moth emergence of *Diparopsis* in various areas of the Federation gave similar results to those obtained the previous season.

When given a choice of cotton plants of different varieties (glabrous, nectaryless and pubescent types) *Diparopsis* moths did not show any significant preference for oviposition. However *Heliothis* moths tended to avoid ovipositing on glabrous cotton, but this was not significant when no choice was offered. There was an indication that insecticide control of *Diparopsis* may be more effective on pubescent rather than glabrous varieties of cotton.

It was shown that certain other carbamate insecticides are also effective in the laboratory against *Diparopsis*.

An established population of *Diparopsis* was controlled in the field using 'Sevin' insecticide, but repeated sprays were necessary to prevent reinfestation.

The published spray recommendations were used in an extension trial in which an average yield increase of 848 pounds seed cotton per acre was obtained from 40 plots. This is 193 pounds more than in the 1960–61 extension trial.

The spray recommendations were also used successfully by African and European farmers in all three territories of the Federation.

Further development work on the 'tailboom' has been carried out especially for improving its efficiency in the field and adapting it for use on large acreages by fitting to tractor and portable line equipment.

REFERENCE

Tunstall and Matthews (1961), Cotton Insect Control Recommendations for 1961–62 in the Federation of Rhodesia and Nyasaland. Rhod. Agr. J. 58 (5) 289–299.

Cotton Pest Research Scheme,
P.O. Box 396,
Gatooma,
Southern Rhodesia.

November, 1962.

TEA

Joint Tea Research Committee

Chairman .. R. W. KETTLEWELL, C.M.G., B.SC. (Reading), DIP. AGRIC. (Cantab.), A.I.C.T.A., until 31/3/62. Resigned upon retirement.
S. T. HOYLE, O.B.E., M.A. (Cantab.), A.I.C.T.A., from 1/4/62.

Members .. Messrs. R. R. A. BISHOP, A. R. WESTROP, B.SC., DR. I. C. CONFORZI, H. M. CADMAN, M.B.E., C. BARROW, B.A., J. S. STREET, J. HAY, the Chief Agricultural Research Officer and Senior Agricultural Chemist of the Nyasaland Government, the Director and Plant Breeder of the Tea Research Stations.

Messrs. J. F. RAMSDEN, A. N. HEARN and J. S. BARR resigned upon retirement.

Resident Scientific Staff

Director	D. H. LAYCOCK, M.SC. (Leeds), A.I.C.T.A.
Agronomic Section	D. H. LAYCOCK, G. A. BRIDGER, G. F. CRASKE, N.D.A., C.D.A.
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T. H. K. MZEMBE, S. W. KAPUNGWA and L. H. B. DOZOLA

Leave—Senior Staff

D. H. LAYCOCK	U.K. Leave, June/August, 1961.
R. T. ELLIS	U.K. Leave and study leave, September to January, 1961/62.

Acknowledgements

As in previous Reports, I would take this opportunity to thank all those many people who have helped the work of the stations during the year.

The assistance from members of the Association at all levels, both officially and personally, continued and provided much-needed stimulation and encouragement to the staff. My most sincere thanks are due to Managers who have, during the season, placed tea or factory equipment at the disposal of the stations. I am conscious of the trouble our requests cause particularly during the rush and hurly burly of the mid-crop season.

The specialist staff of the Department of Agriculture have continued with their generous help and my thanks are also offered to the Director of Agriculture.

No less worthy of acknowledgement is the help and advice we receive from commercial firms, particularly those whose Technical Managers so generously search out for us detail not available in our own library.

My Research Committee met on seven occasions during the year and played its part in the running of the stations.

It is with particular pleasure that once more I can record the happy relationships that exist between the Stations and the Industry.

D. H. Laycock

REPORT OF THE AGRONOMY SECTION

Planting Experiments

SURVIVAL OF TYPES OF PLANTING MATERIAL

With the 1960/61 rains two experiments were planted each at Mimosa and Cholo to compare the effects on survival of various types of planting material and methods of planting. Death counts were taken approximately 12 months after planting, following the first dry season and after the next rains had set in.

The first experiment compares the following treatments and percentage deaths for each station are recorded in Table 1.

TABLE 1

Percentage deaths at Mimosa and Cholo according to treatments

Station	*Pot Length*		*Hole Depth*		*Shading*		*Finger Pruning*		L.S.D. P=0.05
	6″	9″	18″	*Pot depth*	—	+	—	+	
Mimosa	9.4	5.0	5.5	9.1	11.1	6.3	8.0	9.4	3.3
Cholo	16.3	12.4	15.0	13.7	14.8	13.9	13.8	14.9	2.6

C.V.%, Mimosa 32.3 and Cholo 24.2

Seed was germinated in sand and transplanted to polythene sleeves filled with ordinary nursery soil. Approximately six months later the seedlings were transplanted to the field. The first treatment contrast was between seedlings grown in 6″ or 9″ deep sleeves whose diameters were equal and approximately 4″ when full of soil. Each length pot was planted in either conventional tea type holes pre-dug to 18″ depth and later filled to pot depth, or in pre-dug pot depth holes. After planting half the seedlings were left unshaded and the other half shaded at ground level with collar pots. Before planting, seedlings were either left untouched or finger pruned to remove the apical bud.

The overall percentage of deaths was greater at Cholo than at Mlanje and reflects the less congenial conditions there. At Mimosa shading with collar pots significantly reduced deaths which may be because of possibly higher surface soil temperatures obtained in Mlanje than in Cholo. At Cholo the longer pot significantly reduced deaths. It is noticeable that the Cholo potting soils encourage a more rapid rate of rooting depth in contrast with the Mimosa nursery soil and more roots can be seen penetrating the bottom of the pot age for age than at Mimosa. It is possible therefore that relatively less damage was caused to the root systems by the longer pots at Cholo—an effect which was not critical at Mimosa.

There were no other significant differences.

In the second experiment three types of planting material were compared at each station. Seedlings were grown in 6″ deep polythene sleeves as described above. Equally aged seedlings, grown in the conventional nursery manner, were transplanted from the nursery bed to the field with a Herschall transplanter; a hand operated machine which extracts the seedling with a surrounding cyclinder of soil and plants it into a hole in the field prepared with the same sized cylinder. Finally 30 month old stumps from the same seed source were used in the conventional way.

Half of the three types of material were planted as early as is possible and the second half planted approximately one month later. Half of the holes for each of the above combinations of treatments received four pints of water just before planting, the remainder being used without additional water.

TABLE 2

Percentage deaths at Mimosa and Cholo according to treatments

Station		Planting Material			Time		Water	
		Poly. pots	*Herschall*	*30 month stumps*	*Early*	*Late*	—	+
Mimosa		4.9	7.6	2.5	4.1	5.9	5.1	4.9
Cholo		11.9	16.9	1.8	10.3	10.1	9.6	10.8
L.S.D.	Mimosa		2.0		1.6		1.6	
P=0.05	Cholo		3.2		none		none	

At both stations the Herschall method produced significantly more deaths than the polythene pots which in turn were significantly worse than the stumps. Apart from cutting and breaking roots while uprooting seedlings in the nursery, the Herschall tree planter did not prove entirely satisfactory in the field because the soil types at both stations were such that it was found to be very difficult to remove the metal cylinders from the planting hole with a clean, smooth movement. Undoubtedly more damage to root systems must have thereby occurred. The percentage deaths with pots at each station compare satisfactorily with those obtained in the first experiment. Stumps survived as expected from the weather following transplanting. At Mimosa late planting caused significantly more deaths than early planting. There are no other significant differences and the expense of carting and applying water to the field was not justified by better survival thereafter.

A third experiment comparing pots against stumps with other treatments superimposed is but six months old and not ready for report. As it progresses pots are yielding more deaths than stumps.

It would be wrong, however, to conclude that pot planting is not efficient. Yield data must eventually be examined in terms of age from seed and costings and it is hoped that first yields from the first experiments will be taken during the 1962/63 season.

Pruning Experiments

(i) PRUNING CYCLES ON LOCAL JAT TEA, THORNWOOD ESTATE

This experiment has completed ten successive seasons of treatment and yield recording. The season's data do not alter the trends and conclusions recorded in last year's Report and no further routine detail will be recorded until the end of the fourth three-year cycle.

(ii) EFFECT OF TYPE OF PRUNE ON THE YIELD OF IMMATURE TEA

The effect on yield of two contrasting types of prune were recorded from eight year old tea. The first method is to clean-prune at the desired height removing thereafter crossed branches, dormant shoots and dead branches whereas the second method is simply to " cut-across " at the same height with no cleaning out thereafter.

The two pruning treatments were started in April, 1959, but beforehand uniformity calibration had shown no significant differences in yield between the pairs of plots destined to receive the two pruning methods. The nitrogen rate averaged over plots is 60 lb. N. per acre.

TABLE 3

Yield in lb. m.t.p.a. according to pruning method

Date of Prune	Yield season	Pruning method: Clean	Pruning method: No clean	L.S.D. P= 0.05	0.01	0.001
April 1959	1959/60	1,063	1,163	76	—	—
July 1960	1960/61	1,125	1,284	77	108	150
April 1961	1961/62	2,038	2,256	85	118	164

A highly significant increase in yield has followed from not cleaning at pruning time. Estate experience and other experimental observations are showing the benefits from lighter pruning methods than were conventional in the past but it becomes clearer that this change-over in method to be successful, must be interlinked with high nutrition.

(iii) LENGTH OF PRUNING CYCLE AND TYPE OF PRUNE, SWAZI

At the end of the season the long term experiment on unshaded, poor jat Indian tea, had completed 21 years of successive treatments. (The last detailed report was given in the Annual Report for 1958/59.)

The experiment compares the following treatments:—

Code	*Method*
1C	Annual clean prune
1A	Annual cut-across prune, removing approximately half the top hamper with no subsequent cleaning of the framework.
1R	As for 1A, but the centres of the bushes cleaned to about 18" diameter following cut-across.
2C	Two yearly clean prune with no intermediate pruning treatment.
2A	Two yearly cut-across prune, physically as for 1A.
3C	Three yearly clean prune, with no intermediate pruning treatment.

Total yields according to treatments for the past three seasons are given in Table 4.

TABLE 4

Yield in lb. m.t.p.a. according to six different types of prune

	Clean Prune			*Cut-across*			L.S.D. P=		
Treatment	*Yearly*	*2 yearly*	*3 yearly*	*Yearly*	*Yearly plus centring*	*2 yearly*	0.05	0.01	0.001
Yield ..	2,763	3,465	3,888	3,756	3,541	4,266	372	507	687

C.V.% 1959/62 8.53

With the three clean pruned cycles each yearly lengthening of the cycle has caused a significant increase in yield, but the increment is less between the three and two year cycles than between the latter and the yearly clean prune. All the cut-across methods have yielded significantly more than the annual clean prune and the two year cut-across treatment has yielded significantly higher than any other treatment in the experiment. In practice the continual cut-across treatments, even though they have high yield, are not to be preferred because their plucking shoots tend to be small and hard. Quality determinations in due course should provide valuable data.

Centring has reduced yield in comparison with the annual cut-across with no cleaning.

Table 5 gives the three yearly running means for each treatment throughout the life of the experiment and they are listed according to order of yield. Codes are as in the list of treatments above.

TABLE 5

Yield order of three yearly running means by treatments

Season	Yield order of 3 years' running means					
	1st	2nd	3rd	4th	5th	6th
1941/42	—	—	—	—	—	—
1942/43	—	—	—	—	—	—
1943/44	2A	1A	3C	1R	2C	1C
1944/45	3C	2A	2C	1A	1R	1C
1945/46	3C	2C	2A	1A	1C	1R
1946/47	2C	1C	3C	1A	1R	2A
1947/48	2C	1C	3C	1A	1R	2A
1948/49	1C	2C	3C	1A	1R	2A
1949/50	2C	1C	3C	1A	1R	2A
1950/51	2C	1C	3C	1A	1R	2A
1951/52	2C	3C	2A	1R	1A	1C
1952/53	2A	3C	1R	1A	2C	1C
1953/54	2A	3C	2C	1R	1A	1C
1954/55	2A	3C	2C	1R	1A	1C
1955/56	2A	3C	2C	1R	1A	1C
1956/57	2A	3C	1A	1R	2C	1C
1957/58	2A	3C	1A	1R	2C	1C
1958/59	2A	3C	1A	1R	2C	1C
1959/60	2A	3C	1A	2C	1R	1C
1960/61	2A	3C	2C	1A	1R	1C
1961/62	2A	3C	1A	1R	2C	1C

There has been no essential changeover in treatment-trend order of the highest yielders during the past three seasons.

All plots are given the same fertilizer treatment. The nitrogen rate was at 35 lb. N. per acre until 1950/51 when it was increased to 80 lb. N. per acre and since November, 1961, the rate has again been increased to 120 lb. N.

The yield trends are in agreement with other experimental evidence recorded during the past four or five seasons and illustrate the interplay of hardness of prune, length of pruning cycle and nitrogen rate. With low nitrogen nutrition (40 lb. N. or less), shorter cycles and harder types of prune appear necessary, but conversely the optimum use of nitrogen for yield production is at high levels with longer cycles using a light to medium type of pruning method.

Satisfying confirmatory evidence is available from the industry of the above interplay and in fact where nitrogen rates have averaged between 80 and 120 lb. N. per acre with a high tip following prune on a three yearly cycle, subsequent prunes at about an inch above previous pruning marks reveal well developed frameworks of strong, clean wood without in practice necessitating extra " cleaning " in its historical meaning.

(iv) TIME OF PRUNING TEA FOR YIELD PRODUCTION: MIMOSA

Times of pruning treatments were introduced for the first time, as from March, 1961, into the oldest of the three " Complex " Experiments at Mimosa. These experiments, comparing identical treatments, were planted in yearly sequence starting at

December, 1952, and in the oldest replication the following times-of-prune were introduced during the past season.

Prune—1st week in March
Prune—mid-May
Prune—1st week in August

The type of prune given in 1961 was a high cut-across for drought protection, removing about half the top hamper prior to an intended much lower cut-across to be given at the beginning of a three year cycle, starting from 1962.

Yields following the high cut-across for the period June, 1961, to July, 1962, are recorded in Table 6.

TABLE 6

Yield following three times of prune

lb. m.t.p.a.

Date of prune	*Yield lb. m.t.p.a.*	L.S.D. P. 0.05	L.S.D. P. 0.01
1st week March	1,328		
Mid-May	1,625	92	124
1st week August	1,480		

C.V.% 1961/62 = 11.21

Pruning as described during mid May has caused significantly more yield to be harvested than from the other times of prune. Cut across prune in early March has significantly reduced yield below that obtained from the August prune. This is clearly the type of experiment where long term data are desirable and it would not be wise to base firm conclusions on but one season's results. (In normal planting practice the lighter prunes are given towards the end of pruning programmes and the type of prune given to the treatments this season would normally have taken place in June or July.)

(v) TIME OF PRUNE FOR YIELD PRODUCTION—OTHER EXPERIMENTS

(*a*) At Gotha Estate, Cholo District, an experiment with one set of pruning times treatments as in the previous section, was started in 1960/61. The experiment as a whole is divided into three for phasing over three seasons and it will be some years before a completed set of treatment yields is available.

(*b*) At both Mimosa and Cholo Tea Research Stations two times of prune have been superimposed on newly planted experiments. The first treatment is to prune at six months after planting and the second a year later, or 18 months after planting, which is the conventional time. First yields from both treatments will not be available until the 1963/64 season.

Fertilizer Experiments

This section deals with fertilizers applied to unshaded tea planted at one spacing in any one experiment. The interplay of fertilizer with other management methods is reported in other sections and preliminary findings on quality in relationship to fertilizers are given in the Plant Breeder's report.

(i) N.P.K. EXPERIMENT ON IMMATURE TEA: MIMOSA

This experiment was planted in 1953 and increasing rates of fertilizer were applied until a maximum was reached in 1959. Treatments thereafter have been:—

Sulphate of ammonia supplying 40 or 80 lb. N. per acre.
Single superphosphate supplying 0 or 30 lb. P_2O_5 per acre.

Muriate of potash supplying 0 or 30 lb. K_2O per acre, applied in factorial combination and there are two complete replications.

During the past season this experiment has given most perplexing results. Totalled over both replications, phosphate and potash have each caused significant increases in yield at P=0.01 and 0.05 respectively. But the differences are entirely accounted for by the yields from one replication at significance levels of 0.001 and 0.01 respectively. Consequently, pending further soil examination and next season's yield, the result for the past season must be treated with suspicion.

(ii) THREE CUBED FACTORIAL N.P.K. EXPERIMENTS ON MATURE UNSHADED INDIAN TEA, SWAZI (MLANJE) AND NAMIREME ESTATE (CHOLO)

The two experiments have identical fertilizer treatments on equivalent jat tea but differ in that one is in the wetter congenial Mlanje District and the other in the drier conditions of Cholo.

The experiments compared until this season the following fertilizer rates applied in factorial combination:—

Sulphate of ammonia supplying 40, 80 or 120 lb. N. per acre.
Single superphosphate supplying 0, 30 or 60 lb. P_2O_5 per acre.
Muriate of potash supplying 0, 30 or 60 lb. K_2O per acre.

Estates are becoming increasingly interested in applying N. at or above 120 lb p.a. so in view of this move, and also because preliminary experimental evidence from another experiment indicates a yield depression at N. rates above 150 lb. p.a., the original sulphate of ammonia treatments were altered during this past season to read:—

Sulphate of ammonia supplying 40, 120 and 200 lb. N. per acre. Yields according to the new fertilizer rates are recorded in Table 7.

TABLE 7

Effect of N.P.K. on yields of mature tea at Swazi and Namireme

lb. m.t.p.a.

Nutrient	N			P_2O_5			K_2O			L.S.D. P=	
lb. p.a.	40	120	200	0	30	60	0	30	60	0.05	0.01
Swazi ..	909	1,369	1,692	1,327	1,301	1,342	1,291	1,369	1,310	112	152
Namireme	777	1,136	1,373	1,079	1,096	1,110	1,084	1,116	1,085	67	91

C.V.% Swazi, 9.98 and Namireme, 8.82

At both sites increasing nitrogen rates have given highly significant increases in yield (P=0.001). Both experiments show diminishing returns to nitrogen above N120 but past experience would indicate that at least three seasons must pass before the effects of the new nitrogen rates become stabilized. At neither site has phosphate or potash significantly affected yields.

The returns for each added pound of nitrogen are given in Table 8.

TABLE 8

Return in lb. m.t. for each added lb. of nitrogen (N)

	From N40 *to* N120	*From* N120 *to* N200
Swazi	5.75	4.03
Namireme	4.48	2.96

These returns it should be noted are calculated from the full levels of the revised nitrogen rates. It is unlikely that the new rates are fully operative after only one

season and thus the returns are considered to be no more than intermediary figures. (A truer approximation for the season's returns would be roughly double those shown above between N40 and N120.)

(iii) TYPES OF FERTILIZER EXPERIMENT: MIMOSA

This experiment, started at the end of 1959, is conducted on unshaded Indian type tea planted in December, 1951. Before 1958 the tea had received what was considered to be adequate nutrition, fertilizers applied being sulphate of ammonia, single supers and muriate of potash. In 1957 the rate of application had reached 70 lb. N., 25 lb. P_2O_5 and 25 lb. K_2O nutrient per acre but during uniformity procedure during 1958, no fertilizer was given to the tea. Thereafter fertilizers were applied according to experimental plan and are as follows:—

S.A.	Sulphate of ammonia supplying the equivalent of 80 lb. N. per acre. This includes the equivalent of 91 lb. acid Sulphur per acre.
½ S.A.	Half the above quantity of sulphate of ammonia.
U.	Urea supplying the equivalent of 80 lb. N. per acre.
S.	Flowers of sulphur equivalent to 91 lb. acid S. per acre.
½ S.	Half the above rate.
S.G.	Single superphosphate supplying 30 lb. P_2O_5 per acre.
Tp.	Triple superphosphate supplying 30 lb. P_2O_5 per acre.
K.	Muriate of potash supplying 30 lb. K_2O per acre.
C.A.N.	Calcium ammonium nitrate supplying 80 lb. N. per acre.
G.A.N.	Gypsum ammonium nitrate supplying 80 lb. N. per acre.

The tea is now pruned on a 3 yearly cycle and the phosphatic and potassic fertilizers are applied in the last year before prune. The fertilizer applications will be repeated in sequence according to year from prune as detailed at the head of Table 9.

Cumulative yields following the first three years of treatments are shown in the same table.

TABLE 9

Cumulative yields in lb. m.t.p.a. according to time and fertilizer treatment

Season	*Fertilizer treatment (coded)*							
1959/60 ..	U½S	US	½SA	½SA	U	SA	U	SA
1960/61 ..	U½S	US	½SA	CAN	U	U	U	SA
1961/62 ..	U½S+ TK	US+ TK	½SA+ SgK	GAN+ SgK	U+ TK	U+ TK	U+ SgK	SA+ TK
Season	*Cumulative Yields lb. m.t.p.a.*							
1959/60 ..	1,240	1,217	1,231	1,176	1,220	1,199	1,196	1,210
1960/61 ..	3,150	2,996	2,972	2,931	3,007	3,036	2,919	3,082
1961/62 ..	4,748	4,591	4,540	4,512	4,577	4,615	4,449	4,709

No significant differences in cumulative yields are due to treatment effects. Experiments of this nature do not lend themselves to really satisfying designs. Little more can be done than to repeat the fertilizer treatments in sequence over a long range of time and examine cumulative yields as they become available.

All the experiments at Mimosa are on tea no more than 11 years old and throughout the comparatively short time span responses to nitrogen have been low even if significant. Before opening to tea the soil at Mimosa was covered with heavy rain forest and fertility was considered to be high.

On the other hand very rapid responses to sulphate of ammonia have been obtained in both Mlanje and Cholo Districts after sulphate of ammonia applications to tea twenty or more years old.

It must be constantly borne in mind that persistent high rates of sulphate of ammonia without other fertilizers may become eventually proportionally less efficient due to deleterious soil changes and for this reason, apart from any purely economic considerations, it is of importance to have information on the long term effects of not only sulphate of ammonia but other nitrogen carriers. Two experiments, one in Mlanje and one in Cholo, are therefore under uniformity recording on mature tea and at the end of 1962 they will receive three nitrogenous fertilizers each applied at medium, high and very high rates.

Spacing Experiments

(i) FOUR SPACING AND FOUR NITROGEN RATES: MIMOSA

This experiment compares, on unshaded Indian type tea, the following treatments in all combinations:—

Spacings (as originally planted and before the 1957 drought)

4′×4′ square, equalling 2,720 plants per acre.

4′×3′ rectangular, equalling 3,630 plants per acre.

5′×(2½′×2½′) double hedge, equalling 4,650 plants per acre.

4′×(2′×2′) double hedge, equalling 7,260 plants per acre.

Nitrogen from sulphate of ammonia supplying the equivalent of 40, 80, 160 or 240 lb. N. per acre.

During the past season statistically formal significant increases in yield were obtained from this experiment due to increasing plant populations. Yields against plants per acre in plucking are recorded in Table 10, and the data fit onto an asymptotic curve described in the 1959/60 Annual Report. The tea was ten and a half years old at the end of the season. Because of heavy deaths during the 1957 drought the actual populations in bearing differ from the theoretical according to spacing pattern.

TABLE 10

Yield according to increasing plant population

lb. m.t.p.a.

Intended spacing Actual population	4′×4′ 2,285	4′×3′ 2,973	5′×(2½′×2½′) 3,718	4′×(2′×2′) 5,682	L.S.D. P 0.05
Yield, lb. m.t.p.a.	2,070	2,165	2,180	2,346	169

C.V.% 1961/62, 9.09

Significant differences in yield due to sulphate of ammonia applications can be seen in Table 11.

TABLE 11

Yield according to Nitrogen rate

lb. m.t.p.a.

Nitrogen rate	40	80	160	240	L.S.D. 0.05
lb. m.t.p.a.	2,054	2,250	2,301	2,156	169

Yield increases up to N160 but decreases between N160 and N240. A similar pattern was recorded last year when the data were described as fitting to a quadratic

curve with a turning point at N150 below and above which yield decreased. This season a similar type curve satisfactorily fits the data and is, $Y = 2003.4 + 4.3175N - 0.0153N^2$. The fit is not quite as good as for last year's curve at the N40 point and it is possible that a more complicated relationship is developing. It is too early as yet to draw firm conclusions but the turning point this season occurs at N140.

Nevertheless the data for the past two seasons suggest a drop in yield above N140 due to consistently high applications of sulphate of ammonia. The fertilizer history of this experiment is shown below and fertilizers used have been sulphate of ammonia, single superphosphate, muriate of potash and in the early years the low per bush rates of sulphate of ammonia were augmented by dressings of sulphur bringing, for each treatment rate, the total sulphur content applied equal to that of the highest rate.

Fertilizer progression in terms of nutrient applied

1 month after planting, 1 oz. S/Am. per plant regardless of spacing.

Final Treatment	40N	80N	160N	240N	Potash	Supers	Sulphur
1 year	10	20	40	60	—	—	+
2 year	20	40	80	120	—	—	+
3 year	30	60	120	180	—	—	+
4 year	40	80	160	240	60	60	—
5 year	40	80	160	240	—	—	—
6 year	40	80	160	240	—	—	—
7 year	40	80	160	240	60	60	—
8 year	40	80	160	240	—	—	—
9 year	40	80	160	240	—	—	—
10 year	40	80	160	240	60	60	—

Note: P_2O_5 and K_2O are given at the rate of 60 lb. of nutrient per acre each, every third year and in the year before prune.

(ii) THE "COMPLEX", SPACING EXPERIMENTS: MIMOSA

Three experiments, the oldest being ten and a half years, were planted in yearly sequence and compare various treatments, one set being three spacing patterns and another three nitrogen rates. (The effects of time of prune, a newly introduced set of treatments, has been described above.)

The tea, in contrast with the unshaded spacing experiment reported in the previous section, was heavily shaded with *Grevillea robusta*. Shade thinning is now taking place according to the age of each replication.

In all experiments formal significant increases in yield are due to increasing populations and the data fit onto asymptotic curves of yield against plant population.

Significant increases in yield due to increasing nitrogen rates are obtained in the oldest experiment and this coincides either with increasing age and/or the effects of shade thinning. It is not possible to separate with certainty these two effects.

Permanent Shading of Tea

(i) SHADE TREES AND N.P.K.: MIMOSA

This experiment in the Mlauje District compares the effects of three permanent shade trees against unshaded tea and superimposed under each shade treatment are four nitrogen rates with and without phosphate and potash.

In past reports the plots without trees have been simply referred to as "unshaded" plots. Physically this is nearly true, as they are in full sunshine between

8 a.m. and 4 p.m. But other experiments are suggesting that shelter alone benefits yield and because the unshaded plots are, by virtue of the experimental design, mixed with the shaded plots, a more accurate description of this treatment is now considered to be " unshaded and sheltered ". Wind run measurements have started in all plots.

Yields according to shade treatment from the beginning of the experiment are recorded in Table 12.

TABLE 12

Effect on yields in lb. m.t.p.a. of four shade treatments according to age

Season	Age, years at end of Season	Shade treatment and spacing: *Glyricidia maculata* 28 feet square	*Albizzia gummifera* 40 feet square	*Grevillea robusta* 40 feet square	*Unshaded and sheltered* —	L.S.D. P= 0.05	0.01
1953/54	2.5	96	110	112	90	—	—
1954/55	3.5	198	233	235	215	—	—
1955/56	4.5	545	665	662	610	48	75
1956/57	5.5	821	398	968	947	48	75
1957/58	6.5	472	578	736	756	157	246
1958/59	7.5	1,040	1,093	1,432	1,551	248	390
1959/60	8.5	951	874	1,397	1,479	318	498
1960/61	9.5	974	932	1,246	1,451	366	513
1961/62	10.5	1,539	1,235	1,957	2,261	537	843
All Seasons ..	—	6,636	6,618	8,745	9,360	—	—

During the past season the unshaded and sheltered treatment has not significantly outyielded tea shaded with *Grevillea* but this pair of treatments have significantly yielded more than either *Glyricidia* or *Albizzia* shaded tea. This pattern follows previous experience.

One distressing agronomic feature of the experiment is that after 10 years the *Glyricidia* trees appear to be losing vigour and are not now casting the dense and even shade they did previously. This may account for the proportionally higher yield of the *Glyricidia* shaded plots during the past season in comparison with previous seasons.

There are no significant effects from fertilizers.

Soil moisture readings continue to be taken from gypsum blocks placed down to a depth of 10 feet under all plots and lead to the following general conclusions:—

(*a*) In each season a pattern of drying noticeable down to at least 10 feet is followed by wetting of the profile to Field Capacity.

(*b*) Some variations in rate and quantity of moisture usage during the dry season occur, depending upon shade species and whether or not the tea was pruned.

(*c*) With the onset of the rains the profiles begin to fill at the same rate and during the main rains no significant differences in profile moisture contents are shown.

In previous reports it has been recorded that the soil moisture picture was possibly of major importance in explaining the deleterious effects of shade on yield production. Further evidence at present being analysed suggests that soil moisture is not as critically involved as was at first thought, but this suggestion needs further examination and experimentation.

Figure 1 shows a typical yield distribution from the experiment. The associated soil moisture contents as taken from gypsum blocks are figured later in this report under the Soil Physicist's section. The yield graphs are plotted for individual plucking rounds over the 1960/61 cropping season before the *Glyricidia* trees began to degenerate. The tea was cut-across pruned in June, 1960, and clean pruned in April, 1961.

From August until the end of November (the warm to hot dry season) yields show little effects from treatments as Table 13 shows:—

TABLE 13

Yield in lb. m.t.p.a. according to shade treatment and harvested between 10-8-60 and 24-11-60 (Dry season)

Glyricidia maculata	*Albizzia gummifera*	*Grevillea robusta*	*Unshaded and sheltered*
248	273	237	267

Following the onset of the rains the rates of increase of yield are not affected by shade treatment and it is during the main rains that the major differences in yield due to treatment can be seen. Yields harvested during the main rains are shown in Table 14.

TABLE 14

Yields in lb. m.t.p.a. according to shade treatment and harvested between 8-12-60 and 6-4-61

Glyricidia maculata	*Albizzia gummifera*	*Grevillea robusta*	*Unshaded and sheltered*
726	659	1,009	1,184

The significant losses in yield occurred during the vigorous growing season. Conclusions drawn at the present stage of this ten year old experiment are:—

(*a*) That significant losses in yield have been caused by shading with *Albizzia gummifera* or *Glyricidia maculata*. No significant losses in yield have been caused by *Grevillea robusta* trees as yet but detailed data suggests that the proportionate loss relative to no shade is increasing as the *Grevillea* trees grow older and offer more shade.

(*b*) The significant losses in yield occur during the main rains regardless of the extent or rate of drying of the profile according to shade treatment in the previous dry season.

(*c*) During the rains, when the major yield differences occur, and when the profiles are filling or full, the gypsum blocks do not indicate that moisture reserves under any shade treatment differ significantly.

(*d*) With the onset of the rains, yields from shade treatments accelerate equally regardless of previous differences in drying.

(*e*) Because of (*b*), (*c*) and (*d*), it is considered tentatively that shade tree effects on soil moisture have not limited yields.

(*f*) The soil, before planting to tea and shade trees, was under heavy rain forest. No significant effects have yet been obtained from fertilizers. It is concluded that yield has not been significantly reduced under *Albizzia* or *Glyricidia* due to lack of adequate nutrition; at least for the three major nutrients and for the comparatively short life span of the experiment.

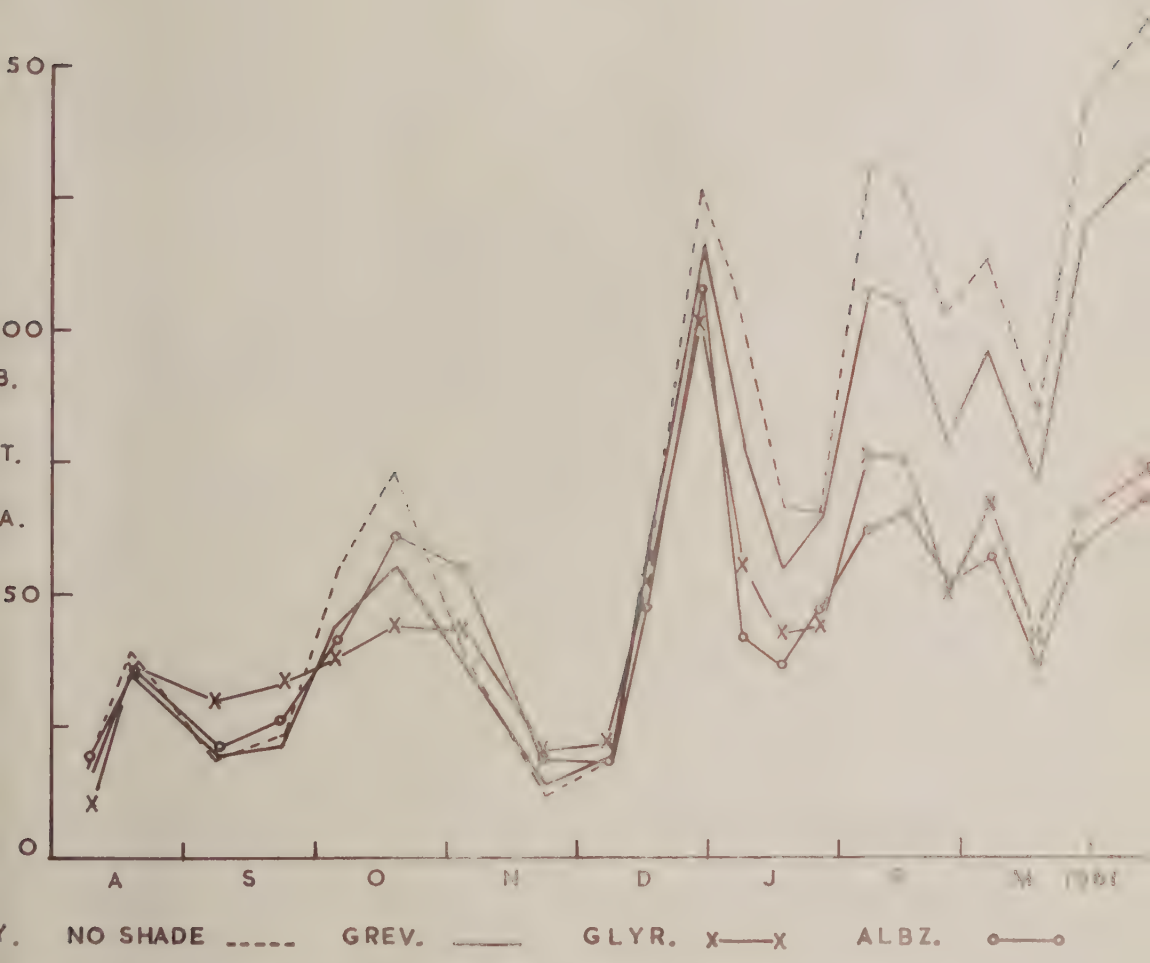


Fig. 1. Yield lb. m.t.p.a. according to time and shade treatment, showing depression in yield under shade during rainy season.

(*g*) The suggestion appears therefore that the losses in yield are due to the effects of shade *per se*. No quantitative measurements of light intensity at the bush surface have been possible but it is clear that the reduction in yield is in order with the density of shade offered by the tree specie used. It has been recorded above that as the *Glyricidia* trees become less vigorous, the yield of the tea shows signs of increasing.

An experiment of similar design was planted at Cholo but with the modification that a shelter belt of pines around the appropriate plots replaces the *Glyricidia* shade treatment. (Pines were chosen for experimental convenience in that they grow rapidly with a compact habit and can be expected to offer shelter from an early age.) First leaf yields will be taken during the 1962/63 season.

(iii) OTHER OBSERVATIONS

There are no major differences in responses to report from the Swazi shade observation plots conducted on tea about 28 years old.

Field I at Mimosa is 16 acres in area and the tea one year older than that of the formal shade experiment. Half of the field, running up and down the slope, is under a museum of various shade trees and for the past two seasons the halves have been harvested separately with yields as below. Both halves receive 80 lb. of nitrogen per acre as sulphate of ammonia.

TABLE 15

Yield in lb. m.t.p.a. Field I, Mimosa shaded and unshaded halves

Season	*Shaded*	*Unshaded*
1960/61	1,436	1,604
1961/62	1,352	1,790

Shade appears to have depressed yield in both seasons.

Climate and Yield

These investigations appear at last to be bearing fruit although some detail has received adverse criticism and consequently firm results can not be published in this report. Briefly, the Penman formula, calculated for intervals of 10 day periods, is able to describe well and with reliable accuracy the moisture reserves under tea for the dry season in Nyasaland when agronomic factors, particularly time and recovery from prune, are taken into account. It is the factors applied to the formula for the wetting and wet profiles that have been criticized. The same formula can be used empirically to give close correlations with yield.

As the calculations stand at present they suggest that very low moisture tensions can rapidly bring about a reduction in yield and that optimum yield production demands freely available water with a high energy environment at the leaf surface.

Similar increases in yield to those reported last year have been obtained from the netted shelter plots and the data will ultimately be reviewed in the light of the revised climate and yield functions.

There are no major changes to report from the Lujenda irrigation experiments for this season. Some concern has been expressed by estates on the comparatively low returns in yield (as opposed to survival) obtained from irrigation. Except for one trial where predicted yields equalled actual yields (Table 15 of the 1960/61 Report) it has

not been possible to examine data of other experiments in the light of the climate and crop correlations. However, a reasonable but crude working hypothesis evolved from the correlations appears to be that soil water under mature tea can be divided into two fractions but the exact dividing line if there is one has yet to be determined with precision. Yield production is considerably reduced on a deficit not exceeding a tentative one inch. It has been suggested as a subject for investigation that a mid day deficit (or wilt) of "perhaps only a few tenths of an inch" may be critical. Thus the first fraction is seen as being a supply of readily available water for optimum yield production, or more precisely, optimum use of available energy. The second fraction is the remainder down to wilting point available for survival and yield production on a rapidly decreasing scale of efficiency. One is tempted to mentally parallel the hypothesis with the production and maintenance rations for livestock. If this hypothesis is near the truth, and it remains to be proved, then irrigation with perhaps one inch at weekly or ten daily intervals is not expected to maintain the field production fraction of the soil moisture at its optimum, certainly towards the end of the dry season when transpirational rates can exceed two inches or more in each ten day period with little natural rain falling to supplement irrigation.

As a basis for experiment this hypothesis is considered to be a step forward and plans are afoot to install and use suitable equipment.

Arboricides

The old experiments on the use of arboricides on *Grevillea robusta* trees and forest species, as described in previous reports, continued and showed results to be obtained during the forthcoming season. Starch can be reduced in *Grevillea* trees and some forest species and the most efficient arboricide is 245-T.

Throughout the life of these experiments starch contents of roots have been determined by the Senior Agricultural Chemist. An important practical point is that there are indications of fluctuations of starch contents under natural conditions according to seasonal growth and dormancy periods. This suggests that there may be optimum times for injecting arboricides for tree destruction, or ring barking, as opposed to merely killing a tree, and thus a new experiment was started this season, on *Grevillea* trees which compares the effects of two strengths of 245-T and ring barking applied at various times of the year.

PLANT IMPROVEMENT SECTION

Controlled Pollination

During the 1961 flowering season 2,002 artificial pollinations were made. A pollination in this sense involves the transference of pollen to one or more emasculated flowers of a given tree which are then enclosed in a glassine paper bag (6" × 4"), in order to prevent any further pollination. The trees worked with were 22 Botjan seed bearers of 7 years from seed.

60 self pollinations were attempted, none of which was successful.

All the remainder were cross pollinations and of these some 500 bags contained immature seed one month after pollination, but due to the premature dropping of seed and the destruction of bags by various agencies only 401 bags remained with mature seed at harvest time. From these bags, 762 seeds were taken but only 401 were successfully germinated, many being "light" seeds; others were spoiled by being harvested by mistake before they were mature.

The results on the whole must be considered as fairly satisfactory in view of the normal low percentage of tea flowers; as Harler states (The Culture and Marketing of Tea): "Only about 2 per cent. of the flowers on a tree set to form seed, although the

artificial transfer of pollen may raise the set to 14 per cent." Commercial producers of seed also know that of seed harvested, anything up to 30 per cent. can be "light" seed of doubtful viability.

The main object of this work was to test the combining ability of a group of 22 individual seed-bearers which had been selected on the grounds of fermentation ability as clones for inclusion in ten clone seed gardens. Much valuable data was gained towards this end in respect of flowering dates and the ability of pairs of trees to cross with one another. The 401 seedlings have been established in polythene pots and will be planted out into the field in [illegible] acres, where they will give a picture of the sort of progeny to be expected from individual pairs of trees and also from the clonal seed gardens which have been established from different combinations of these clones.

During the 1962 flowering season (May—August) 4,700 pollinations were made. From amongst the eight year old Betjan seed bearers a further series of trees had been selected and crosses were made between them. Permission has also kindly been given by the Management of Lapry Estates for the use of certain selected trees in their seed garden and pollen was brought from these and crossed on to the selected Betjan trees. Crosses were also attempted between the Betjan trees and certain Indian Hybrid and China Hybrid bushes with special characteristics. Interest was also revived in self pollination and with the use of a new technique some 1,800 pollinations were attempted.

Clonal Seed Gardens

Experience was gained in 1961 in the planting of a small clonal seed garden using cuttings rooted into polythene pots. It was shown that a garden could be established rapidly in this way providing the cuttings had developed roots before planting out and if shaded and watered. This is seen as an important method by which the industry can be provided with improved planting material in a comparatively short space of time.

Clonal seed gardens have many advantages over those established from seedlings. Because they are composed of only a small number of separate genotypes—we propose to use ten clones at the most—the components can be highly selected. It is possible in a reasonable time to find ten or so plants which meet one's requirements for certain characters, whereas it is very much more difficult and may even be impossible to find 500 which do so. As the number of possible parent genotypes is small so the variation amongst the progeny will be limited and thus the seed coming from the garden should give plants which will be very even and "true to type." By doing controlled pollinations, the type of the progeny can be seen in advance. If, as in general will be the case, the mother bushes from which the clones are established have reached the flowering stage, the clonal plants will be capable of bearing flowers and seeds as soon as they have made sufficient vegetative growth and will not have to pass through the juvenile flowerless stage which may last for five to seven years with seedlings.

We have selected clones from within the population of Betjan jat which are growing as seed bearers at Mimosa. The main point of selection has been fermentation ability and this has been tested by the various methods worked out in detail by the Cambridge team and based on the general principle of assessing by colorimetric methods, the amount of thearubigins and theaflavins developed during fermentations. All the clones selected have above average fermentation ability according to these tests. Attention has also been paid to the general appearance of the bushes and their leaf type in order to keep them within the general type of large broad leaf Assam tea. Pubescence has been noted but this has not been used as a major factor in selection.

Selection of clones has been carried out in 1960, 1961 and 1962 and in each year with improved techniques and increasing experience, the field covered has been larger and the selection criteria have been applied more rigorously.

In 1960 five trees were selected and propagated so that during the 1960/61 rains a small clonal seed garden of 100 plants was established.

In 1961 an additional sixteen trees were selected and propagated and during the 1961/62 rains the five clone Mimosa seed garden was increased to a total of 300 trees and also two seed gardens were established on estates in Cholo. Each garden was planted with a combination of ten clones, one garden consisted of 500 plants and the other of 270. As at July, 1962, the stand in these gardens was 95 per cent. with most plants growing away vigorously.

In 1962 a further eight trees were selected and only eight of the previous trees were retained for working upon. From these sixteen trees some 4,000 cuttings have been taken for propagation and in the 1962/63 rains it is proposed to establish ten clone seed gardens on four estates in Mlanje and two in Cholo.

This work will be of great practical value in providing the industry with improved material as rapidly as is possible but it is also essential to plan more long term breeding plans. These involve the screening of material to find those that are really outstanding bushes and pairs of bushes which combine perfectly to give outstanding progeny, thus being suitable for the planting of biclonal seed gardens.

Field Selections

As detailed in this report for 1960/61 these consist of a number of different series of selections.

(*a*) The Swazi Field Selections comprised 230 Indian Hybrid bushes; on the basis of yield and fermentation some 28 were selected. During the year under review these were allowed to grow up, cuttings taken in November, 1961, and April, 1962, and rooting trials conducted. These are not finalized but preliminary indications are that 15 of these clones are also good rooters.

(*b*) The Mimosa Field Selections originally comprised some 500 Indian Hybrid bushes selected primarily on survival in the 1957 drought. Since then after testing for fermentation, yield and rooting ability, the numbers have been reduced to 21 clones which were propagated and are growing at Mimosa as clonal rows of from 10 to 90 bushes. These were planted out as 30-month-old stumps in 1960 and received their first prune in May, 1962. Thus they are in a more advanced stage in that their performance as clones in the field is known to some extent. During the year the fermentation ability of these clones was reassessed critically and on this basis and on their appearance as clones in the field, five were selected as suitable for planting commercially. The prunings of these clones were taken for propagation and the building up of nucleus stocks.

(*c*) Mimosa Timgamera Selections: some 110 bushes of this jat of Assam tea are currently being tested for yield and fermentation. As 82 of these are young bushes, opportunity was taken to propagate them at their first prune and a number have shown themselves to be good rooters.

Estates Variety Trial

This trial sets out to compare the yield and quality of tea derived from the seed gardens of estates in Mlanje, Cholo and Rhodesia and also of three imported jats. In order to start the trial without delay in 1960/61, planting material was obtained in the form of stumps from estates and from the nurseries at T.R.S., Mimosa. Unfortunately this introduced a weakness into the trial in that the size and general condition of the stumps representing the different jats reflected not only inherent differences but also the varying nursery conditions in which they were produced. This has undoubtedly had a considerable effect on the establishment and early growth of the different jats and the results so far obtained must be interpreted bearing this in mind.

Vacancies caused by deaths of the first planted stumps were supplied up to 100 per cent. at the onset of the 1961/62 rains. General notes were made on the growth and appearance of the jats and at sixteen months from planting out every plant was scored for leaf type. At eighteen months from planting all plants which were big enough were given their first prune of a straight cut across at 12 inches and the prunings were weighed. Past experience has shown that pruning weights are closely associated with general vigour and yield.

Planting material was obtained from estates on the understanding that results pertaining to individual jats would be treated as confidential to the managers concerned; thus only general results can be given, as under.

(*a*) LEAF TYPE SCORES

Leaf type scores are important in this trial for various reasons. Leaf type is important directly in trial the size, texture and position of the flush leaves influences ease of plucking and yield, but also the leaf type can be taken as indicative of the genetical make up of a jat and whether it is mixed or even. It is undoubtedly also associated with other general characters of agronomic importance and particularly with tea making characteristics. Scores were made on individual plants using the following broad categories.

1—China Hybrid or "Nyasaland Local"; small (2½"-3½" × 1"-1½") harsh leaves, often upright and infolded.

3—Indian Hybrid; medium sized (5"-6" × 2"-2½") leaves, fairly soft and rigid, not much infolded, horizontal.

5—Assam type; large (7"-8" × 3½"-4") leaves, soft with the areas between veins raised, general shape convex and hanging with a prominent tip.

2—Intermediate between China Hybrid and Indian Hybrid.

4—Intermediate between Indian Hybrid and Assam type.

Scores were awarded by eye judgment and were therefore to a certain extent subjective but the results for the two identical trials at Cholo and Mimosa gave on the whole very consistent results. When analysed statistically the coefficients of variation in the results were low at 5 per cent. and 6 per cent respectively and highly significant differences between the jats were recorded.

It was possible to divide the jats present into eight different classes. Although a group of the Indian Hybrid type could not be distinguished one from the other in the field many jats were clearly recognizable either by their leaf type or by their evenness or unevenness.

The Betjan which came from the Botanic Gardens, Entebbe, Uganda, was the nearest to pure Assam type of any in the trial.

On the whole the different jats obtained the same score at Cholo as at Mlanje. There was no indication of jats reacting to the generally drier and harder conditions at Cholo and altering their form more towards the China Hybrid type.

Although there were exceptions there was a tendency for jats from Mlanje seed gardens to get higher scores at both stations (more towards the Assam type) than those from Cholo (more towards the China Hybrid type).

(*b*) PRUNING WEIGHTS

As mentioned above pruning weights were probably affected not only by jat but by size of stump planted, this influence being felt not only through growth of individual plants but also in a poor survival from the smaller stumps, especially at Cholo.

The much better establishment and more luxuriant growth at Mlanje is shown by an 89 per cent. establishment on first planting and average pruning weight of 40.8 lb. per plot of 20 bushes as compared with an 82 per cent. stand and average pruning weight of 13.0 lb. per plot at Cholo.

When analysed statistically the results showed high coefficients of variation and significant differences were not clear cut. At Cholo however the treatment with the highest pruning weight, of 20.9 lb. per plot and significantly better than all others except one, was not a true jat but a mixture of clones vegetatively propagated from single node cuttings and planted out as 2½ year old stumps. This material was exceptionally well produced by Mr. H. Brewer of Gotha Estate, Cholo, who kindly agreed to enter it to the trial. The stumps were all of about 1" diameter at 4" above ground level, however the roots were of the usual rather shallow and much forked type associated with rooted cuttings. This result must be regarded as of the first importance as it demonstrates that vp material can succeed in competition with stumps produced in the ordinary way from seeds and especially so as this has happened in the most testing conditions at Cholo. The result would have been even more interesting had the material consisted of a single known clone but in fact the clones comprising it were selected at random from a field and their origin is not known with certainty. The material is however fairly uniform and was given an average score of 3.2 for leaf type.

The jat with the next highest pruning weight at Cholo and not significantly different from the vp treatment was Betjan with an average weight of 18.1 lb. per plot. At Mlanje also this jat gave the heaviest pruning weight with 58.6 lb. per plot; although here three were 5 other jats which also gave over 50 lb. per plot. Altogether the Betjan has been the outstanding treatment in the trial to the present in evenness of type, in general appearance and in general vigour. This is satisfactory vindication of the policy of concentrating most attention on this type of material in the plant breeding work of these stations.

An important aspect of this trial in future will be studies of the tea making characteristics of the various jats for which work we shall soon have adequate facilities.

During the 1962-63 planting season duplicates of this trial will be planted at Mimosa and Cholo using seed planted in polythene pots. This will have the great advantage that all will start in the same conditions and that there will be no differences in nursery treatments to obscure real differences between the jats.

The Effect of Fertilizers on Tea Making Quality

The relationship between the mineral status of individual tea bushes and their fermentation ability was studied as part of the Cambridge University investigation into the biochemistry of Nyasaland tea, but no conclusive results were obtained. However the work suggested that we should attempt to find out whether there was any consistent difference in tea making quality between the plots of N.P.K. fertilizer trials. The trial worked on up to the present has been the three cubed factorial N.P.K. experiment at Swazi (Mlanje). It has three rates of application of N.P.K. fertilizers in all possible combinations, as under:—

	Level			
	0	1	2	
N	40	80	120	lb. N per acre as sulphate of ammonia
P	0	30	60	lb. P_2O_5 per acre as superphosphate
K	0	30	60	lb. K_2O per acre as muriate of potash.

There are two replications and each plot consists of 174 bushes. The fertilizer treatments have been applied annually since 1952 on a stand of well grown mature tea of an Indian Hybrid type but of a rather mixed jat.

The tea was manufactured in the miniature plant at Minosa to the following programme:—

(*a*) rolling in Pizzy rollers, 25 minutes with varying pressures.

(*b*) passed twice through a single section C.T.C. machine.

(*c*) fermentation, 2 hours 35 minutes at 75°–80°.

(*d*) firing on trays in electric oven with forced draught 140° at start rising over a period of 25 minutes to a finishing temperature of 210°F.

Two shoots from each bush in the plots were plucked for manufacture and withered to about 68 per cent. on tats.

In order that fair comparisons could be made, teas were only compared which had been plucked at the same time and manufactured in as nearly as possible, identical conditions. In order to test the residual effects first, only some of the major treatment combinations were manufactured. Seven such sets of teas have now been reported upon by professional tea tasters in London and the summary given below represents seven independent assessments by six different authorities.

Placings on characteristics of liquors and infusions and prices per lb.

Plot	*Yield lb. per Acre* 1960/61	*Report*						
		A	*B*	*C*	*D*	*E*	*F*	*G*
NO PO K2 ..	657	1st	2nd (5/–)	4th (4/4)	2nd (4/6)	1st	2nd	1st (5/–)
NO P2 KO ..	679	—	4th (4/8)	1st (4/10)	1st (4/9)	2nd	inf	2nd (4/10)
NO P2 K2 ..	657	2nd	1st (5/6)	2nd (4/9)	—	4th	1st	—
N2 P2 K2 ..	1,525	4th	2nd (5/–)	inf	inf	2nd	inf	3rd (4/4)
N2 P2 KO ..	1,274	5th	5th (4/6)	inf	inf	inf	3rd	inf (3/9)
N2 PO KO ..	591	3rd	6th (4/2)	3rd (4/7)	inf	inf	inf	inf (3/11)

From the above table it is seen that there is a distinct preference for the teas from the plots which receive the heaviest applications of superphosphate and muriate of potash (with the lowest level of nitrogen, either together or separately (NO PO K2, NO P2 KO, NO P2 K2) as compared with the plots receiving sulphate of ammonia only (N2 PO KO, NO PO KO). The plot receiving a high rate of all three fertilizers occupies a somewhat intermediate position and this is a very important feature when yield as well as tea and in quality is considered. The high phosphate and potash but low nitrogen plots, whilst producing better tea have nevertheless been yielding only about 650–700 lb. of made tea per acre or about half the yield of the plot with high nitrogen only. However, the N2 P2 K2 plot has not only given a better yield (though not significantly better statistically than the N2 PO KO), but has also given better tea than the N2 PO KO. The tea from the N2 PO KO plot is not markedly inferior to that from NO PO KO and therefore it seems that the differences lie not so much in a deleterious effect from applications of sulphate of ammonia, but rather in a beneficial extra effect produced by the other two fertilizers. Thus it might be thought that there would be possibly some advantage to be gained from even higher rates of phosphate and potash when the highest rates of nitrogenous fertilizers are being used; this will need to be tested.

Certainly one effect of the high N. treatments is to produce a much darker green flush than that from plots with low rates. On the NO PO K2, NO P2 KO and NO P2 K2 plots especially, the flush is a light yellow green and this of course leads to a bright

infusion although it does not in itself affect the colour of the tea liquor. It is rather to be doubted that even very high rates of applications of P and K would lighten the colour of the flush on tea receiving high rates of N., but this point remains to be tested.

It is clear that for the economic production of tea, heavy applications of nitrogenous fertilizers must be used and the problem is to find the rates of phosphate and potash which are necessary to improve the quality of the tea in the presence of such high N. applications.

It must be emphasized that the results given above are derived from a single field experiment and that only small quantities of tea were manufactured with a miniature plant. No sweeping conclusions should therefore be drawn at the moment; a trend can be seen however which gives a guide for further investigations. These will be conducted using the small scale manufacturing plant consisting of a roller to take 10 lb. of withered leaf and a two section C.T.C. machine at present being constructed for use. This will enable larger quantities of tea to be manufactured in conditions more nearly akin to commercial production and in conjunction with the Agronomist, the N.P.K. fertilizer experiments at Swazi and at Cholo will be studied as well as tea from other sources as may be indicated.

Horticultural Work: General

As during 1960/61 the emphasis this season has been on the production of rooted cuttings rather than on rooting experiments. The interest in vegetative propagation shown by the industry continues to grow; six estates were provided with material and cuttings and two were given rooted cuttings to establish clonal seed gardens. More attention has been given to grafting selected clones onto seedling root stocks, with a view to establishing new seed gardens or improving existing ones. It is too early to draw conclusions from the results that are available but there are useful indications as to the methods and seasons of working which may prove most suitable; it is expected that some definite results will be available in the next year.

The Vegetative Propagation of Cuttings Under Lath Shades

(*a*) THE EFFECT OF FOUR SOIL TYPES ON THE ROOTING OF CUTTINGS

The experiment reported in the Annual Report for 1960/61 (page 29) was repeated. The results were as under:—

TABLE 16

The effect of four soils on rooting index of tea cuttings

	Soil Type				*C.V.*	L.S.D. P=		
	Mlanje Red	*Cholo Red*	*Mlanje Black*	*Cholo Black*		0.05	0.01	0.001
Cholo	693	674	291	561	8.6%	147	206	291
Mlanje	306	402	134	187	11.0%	*Analysis on transformed data*		
% Coarse Sand ..	23	28	32	32				
% Fine Sand ..	16	22	31	25				
% Silt	8	6	10	10		**Soil Analysis**		
% Clay	45	37	23	24				
pH	5.3	5.4	5.1	5.4				
C/N Ratio	12.3	12.4	10.2	15.1				

At Cholo the three other soils were significantly better than the Mlanje Black; at Swazi, Mlanje Red was significantly better than Mlanje Black and Cholo Red significantly better than either black soil. The poor results at Mlanje are attributed to poor management. The results for 1961/62 are in the same trend as those for 1960/61 in that they are in favour of the red soils, but the differences are less pronounced.

From analysis of the soils for both years, the texture of the media seems to be the only differing factor. The sandier black soils would be expected to have a better air, moisture ratio than the red soils and should be better rooting media, but the results have favoured the heavier red soils. It could be that the black soils were unable to retain adequate moisture for the 3 to 4 days between waterings, and that with more frequent waterings they could be better than the red soils. It is hoped to put down a small trial during 1963 to see if the black soils with extra water do make good media, but at present the recommendation remains in favour of red soils watered about twice weekly.

(*b*) LARGE LEAFED CLONES

Past work on these stations, which has led to the development of techniques for the propagation of single node cuttings in beds under layers of bamboo lath shades, has been done with Indian Hybrid clones. In 1961 some 8,000 Betjan jat cuttings were planted and treated in the same way. The overall percentage of rooting was 48 per cent. with a range of 3 per cent. for the worst clone to 94 per cent. for the best. The overall success on untested material is satisfactory and it would seem that the methods of rooting developed on the Indian Hybrid jats is also applicable to Betjan and other large leafed jats.

(*c*) OTHER EXPERIMENTS

The following experiments are at present being conducted but no results will be available until they have been concluded, when the material is planted into the field as 30-month-old plants.

(i) The effect of transplanting rooted cuttings at 6 months from striking to nursery beds, compared with undisturbed plants.

(ii) The effect on plant form of cuttings made from horizontal or vertical shoots.

(iii) The effect of N.P.K. on the growth of cuttings.

(iv) The effect of two rooting compounds on cuttings.

(*d*) ROUTINE WORK

During April/May, 1961, some 15,000 cuttings mainly for Indian Hybrid selections were planted out.

The Vegetative Propagation of Cuttings Under Polythene Cloches

As had been mentioned in previous reports, polythene cloches are an aid to rooting and are labour saving. Thus considerable attention has been given to this use during the past year. In all cases the cloches have been under a conventional nursery shade and have been used in the following ways:—

(*a*) As an intermediate stage for cuttings rooted in polythene bags under the mist unit; this has enabled the rooted cuttings to be hardened off satisfactorily.

(*b*) To cover cuttings in polythene bags—some uncalloused, others pre-calloused in the mist—with results nearly as good as cuttings rooted under the mist unit.

(c) To cover cutting planted direct into nursery bed. Nearly 2,000 cuttings were planted in late November and there was a survival of 74.5 per cent. in the following May. The only attention given to these cuttings after planting was watering and weeding twice and careful checks on the overhead shade. The ability to root cuttings in November and the easier method of two crops of cuttings from a selected bush to be used as a rotation, also the top of the aforementioned plants being stumped can also be used to provide cutting material. This extra period means a much accelerated build up of material from highly selected bushes.

The early growth of some clones under shade is very chlorotic. This is thought to be caused by an imbalance of shoot and root growth. Attempts are being made to overcome this trouble, but to date without success.

When cuttings are rooted under bamboo laths there are definite good and bad rooters, which are reflected by the widely varying percentage parts surviving. Under polythene cloches the percentage survival is very high and the difference is rather in quick and slow rooters. A cutting when rooted should be gradually hardened off, especially under cloches where the hot and humid conditions are ideal for fungal development, but hardening off should not be so rapid as to cause a check on growth. This means that some clones are ready for hardening sooner than others, thus each clone should be given an individual check so that hardening off may be started when that particular clone is rooted.

Mist Propagation Unit

The unit has been used entirely on production lines this year and no experiments were carried out. The use of polythene bags, with drainage holes, filled with an uncompacted medium of 2 sand : 1 soil with pH around 6, has been found satisfactory. As with polythene cloches there has been no consistently poor rooting clone but there is an indication of quicker and slower rooting clones; the early pale growth mentioned above also occurs under the mist unit.

The after care of mist rooted cuttings has represented some difficulties but by using uncompacted medium and polythene cloches as an intermediate stage, satisfactory results were achieved.

Transplanting of Rooted Cuttings

It has been normal practice to transplant 6 month old rooted cuttings from a striking bed to a nursery bed. In an attempt to observe effect of transplanting on root growth four methods were used:—

(i) All soil shaken from the roots

(ii) the soil was balled around the roots

(iii) a Herschall planter was used to move roots in a core of soil

(iv) soil was removed and the roots reduced to a single downward root, in hopes of developing a tap root.

The rooted cuttings were washed out 6 and 12 months after transplanting and scored together with an examination of the growth. There seems little difference on root development or growth caused by the method of transplanting.

As mentioned above there is a transplanting trial in hand; although results are not yet finalized it seems likely that a considerable check to growth is caused by transplanting cuttings from the striking bed to the nursery. This leads to the recommendation that cuttings from the clones *of known rooting ability* should be planted at 6″ × 6″ in a site where the laths can be replaced by a high shade. To plant unknown clones at a wide spacing is wasteful of striking and nursery beds, bricks and shades.

Field Establishment of Rooted Cuttings

(*a*) 30-MONTH-OLD STUMPED CUTTINGS

It was reported on page 31 of last year's report that at 6 months there was a correlation of stem diameter with survival. These figures were confirmed by recordings of survival at 12 months. There was only a small decrease in the number of survivors between 6 and 12 months. The overall survival at 12 months was, Cholo 56 per cent and Mlanje 61 per cent, and it must be remembered that more than half of these stumped cuttings were smaller than the $\frac{3}{8}$" diameter suggested as a minimum planting size.

During the 1961/62 rains a further 3,400 stumped cuttings were planted, 3,200 of which were at least $\frac{3}{8}$" diameter at 4" above soil level; these gave 66% survival at 6 months, but included some clones which failed after transplanting.

There are some clones which do not seem able to survive the transplanting from nursery to field; one clone (SW 3) in particular died out completely both at Cholo and Mlanje when planted at each station on 5 different dates.

(*b*) TIME OF PLANTING 30-MONTH-OLD STUMPED CUTTINGS

During the 1960/61 rains stumped cuttings from 18 clones were planted over an eight-week period at both Cholo and Mlanje, the starting date for the earliest planted treatments being determined by local weather conditions. The plants at Cholo received water during the dry weather but those at Mlanje did not. These plants were pruned to 12" in May, 1962, and the prunings of each plot were weighed separately. These weights expressed as pounds per surviving plants are given in Table 17.

TABLE 17

Effect on mean pruning fresh weights lb. per bush of various planting times
Plots pruned mid-May, 1962

Station	*Date planted*	*Pruning weight*
Mimosa	30–11–60	2.9
	14–12–60	2.9
	28–12–60	2.3
	11– 1–61	1.6
	24– 1–61	1.5
Cholo	20–12–60	1.1
	4– 1–61	1.0
	17– 1–61	0.7
	31– 1–61	0.6
	16– 2–61	0.5

Pruning weights can be taken as a measure of growth made and the table illustrates the benefits of early planting. At Mlanje and Cholo early planted plots put on almost twice as much growth as those planted one month to six weeks later. It is interesting to note that although differences due to planting date might well be expected during the rainy season following planting, they did in fact persist throughout the second rains and were not evened out up to first prune at about 18 months after planting.

(*c*) SMALL PLANTS IN POLYTHENE POTS

Cuttings rooted under the mist unit or polythene cloches in polythene bags were established as seed gardens in both Mlanje and Cholo Districts. In both districts the young plants were protected by a 3′ × 3′ grass shade and were watered regularly. It seems unlikely that this method will be practical for field planting but it is useful for the establishment of clonal seed gardens.

Grafting

Grafting is potentially a very useful tool in the plant improvement programme; if perfected it could be used for the conversion of individual trees or even whole gardens—particularly seed gardens—by the grafting of improved scions onto existing rootstocks. It may also have such specialised uses as the induction of early flowering. It is reputedly very difficult to graft teak successfully, but a programme is now under way comparing the success or otherwise of a number of possible methods.

During the year the following types of graft were tried:—

(*a*) On old root stocks of 3"–4" diameter; cleft and rind grafts.

(*b*) On young stocks (less than 3 years old or young shoots (under 18 months old), on old stocks: approach and bottle grafts; splice, whip and tongue and side grafts; a veneer graft; modified Forket (patch) and shield bud grafts.

The rind and bottle grafts were a complete failure; the cleft, splice, whip and tongue and side grafts produced a very low percentage of success. Several approach grafts were successful and a few of these are now established in the field. The veneer and modified Forket bud grafts were successful at times up to about 70 per cent. but this level of success could not be maintained regularly; to a much less extent the shield bud was also successful.

By grafting at weekly intervals throughout the year the effect of season and growth cycle on grafting is being recorded. This data will not be complete until December, 1962, but it seems likely that grafting will be more successful in a flush period than a dormant one.

Nearly all the grafts which were successful have been on 2- or 3-year-old seedling stocks. Younger stocks present difficulties because of their small diameter. A few grafts on young shoots from old stocks were successful and it is hoped to increase this success by heavier shading.

Some 20 grafted plants have been established in the field and the establishment does not seem to be a big problem. Some 300 grafted plants should be available for field establishment in the next rains.

The year under review has been the first full year's work on grafting and some useful figures have been collected. The complete results which will become available during 1962/63 should lead to a fuller understanding and development of a successful method in the next two years.

Experiments and Observations with Eucalyptus

Two experiments to observe the effect of fertilizers and insecticides on the growth of *Eucalyptus saligna* seedlings were described on page 35 of the report for 1960/61 and they were continued in the season under review.

(i) THE EFFECT OF SULPHATE OF AMMONIA, SUPERPHOSPHATE AND DIELDRIN ON GROWTH

Applications of sulphate of ammonia, single superphosphate and Dieldrin were continued during the present season, this being the third year from planting, but no significant effects on growth were recorded. In this experiment sulphate of ammonia (150 lb. per acre) and Dieldrin (1.5 lb. active ingredient per acre) gave significant increases in growth in the first and second years from planting, and superphosphate (70 lb. per acre) in the first year only.

(ii) THE EFFECT OF SULPHUR AND UREA ON GROWTH

Due to the use of a wrong conversion factor the results of the experiment comparing the effects of sulphur and urea on the growth of newly planted Eucalyptus trees were incorrectly given in tables 30 and 31 of the 1960/61 report. The correct results for 1960 and those for 1961 are given below.

TABLE 18

The effect of sulphur and urea on the growth of young Eucalyptus saligna

A. AT SWAZI (MLANJE)

Growth to October, 1960 in feet per acre (1st year seedlings)

		lb./acre Nitrogen			*Mean for S*
		0	30	60	
lb./acre	0	4,672	4,783	4,910	4,771
Sulphur	30	7,137	5,660	5,606	6,113
	60	5,377	5,349	6,622	5,762
Mean for N.		5,709	5,245	5,693	5,490

C.V. = 16%

Growth to October, 1961, in feet per acre (2nd year seedlings)

		lb./acre Nitrogen			*Mean for S*
		0	30	60	
lb./acre	0	13,643	13,430	11,985	13,015
Sulphur	30	14,747	16,295	15,606	15,545
	60	17,340	11,832	12,002	13,721
Mean for N.		15,230	13,848	13,193	14,106

C.V. = 13%

B. AT AMALIKA (BVUMBWE)

Growth to October, 1960, in feet per acre (1st year seedlings)

		lb./acre Nitrogen			*Mean for S.*	L.S.D. *Main treatments* P=		
		0	30	60				
lb./acre	0	1,953	2,147	1,954	2,054	0.05	0.01	0.001
Sulphur	30	1,920	3,007	3,371	2,815			
	60	2,063	2,939	3,386	2,846	783	1,061	1,421
Mean for N.		1,994	2,766	2,956	2,436	—	—	—

C.V. = 12%

Growth to October, 1961, in feet per acre (2nd year seedlings)

		lb./acre Nitrogen			*Mean for S*	L.S.D. *Main treatments* P=		
		0	30	60				
lb./acre	0	5,368	6,721	5,675	5,917	0.05	0.01	0.001
Sulphur	30	5,310	8,266	8,942	7,501			
	60	5,553	8,190	8,849	7,533	1,871	2,535	3,395
Mean for N.		5,406	7,720	7,824	6,547	—	—	—

C.V. = 16%

The differences in growth at Swazi were not statistically significant but this may be due to the fact that there are very few replications in this experiment and there have been previous applications of sulphate of ammonia on the same ground.

At Amaliua the differences were significant and there was an interaction between the effects of nitrogen and sulphur. However there are no worthwhile gains from applications exceeding 2 lb. nitrogen per acre. This experiment will be continued in the 1962/63 season but as the trees will be in their third year the expectation is that there will be no further responses to the fertilizer treatments.

(iii) GENERAL OBSERVATIONS

At the Chole station various species of eucalyptus have been established from seedlings grown in polythene pots and opportunity was taken to record some simple treatment effects. The pots were planted in December, 1960, and after establishment half of each plot was given 1 oz. of sulphate of ammonia per tree and throughout Dieldrin was used to control termites. Twelve months later the following measurements were taken and the support for the treatment effects noted from formal experimentation of sulphate of ammonia during the first year.

TABLE 19

Variety	*Height in feet*	
	With Fertilizer	*Without Fertilizer*
E. grandis	16.2	13.7
E. maideni	15.5	11.2
E. saligna ex South Africa	15.1	15.1
E. saligna ex Somba	13.7	12.0
E. tereticornis	14.3	11.3
E. microcorys	12.2	10.2

Soil Physicist's Report

by

R. A. Wood, Department of Agriculture

(i) SOIL MOISTURE USE UNDER MATURE UNSHADED TEA, SWAZI AND NCHIMA

Readings of gypsum blocks installed at various depths to 17 feet 6 inches under pruned and unpruned tea were taken at regular intervals at both Swazi and Nchima throughout the 1961/62 season.

The changes in available moisture since June, 1960, as indicated by the blocks at both sites are compared graphically in Figure 1.

Although the overall moisture use pattern is similar at both sites, in that more rapid drying out of the profile occurs under the unpruned tea, pruning having delayed moisture loss, variations in rainfall and evaporation rates, and to some extent soil moisture characteristics between the two sites (see Table 20), produce quite marked differences in time and rate of drying.

TABLE 20

Rainfall and available moisture data, Swazi and Nchima

Rainfall (in.)		*Pan Evaporation (in.)*		*Texture*		*Available water (in. per foot)*	
Swazi	*Nchima*	*Swazi*	*Nchima*	*Swazi*	*Nchima*	*Swazi*	*Nchima*
Nov. '60–Oct. '61		*Nov. '60–Oct. '61*		Clay	Sandy Clay	1.80	1.40 (*approx.*)
70.69	59.34	57.99	66.74				
Nov. '61–Oct. '62		*Nov. '61–Oct. '62*					
60.58	47.99	56.41	70.35				

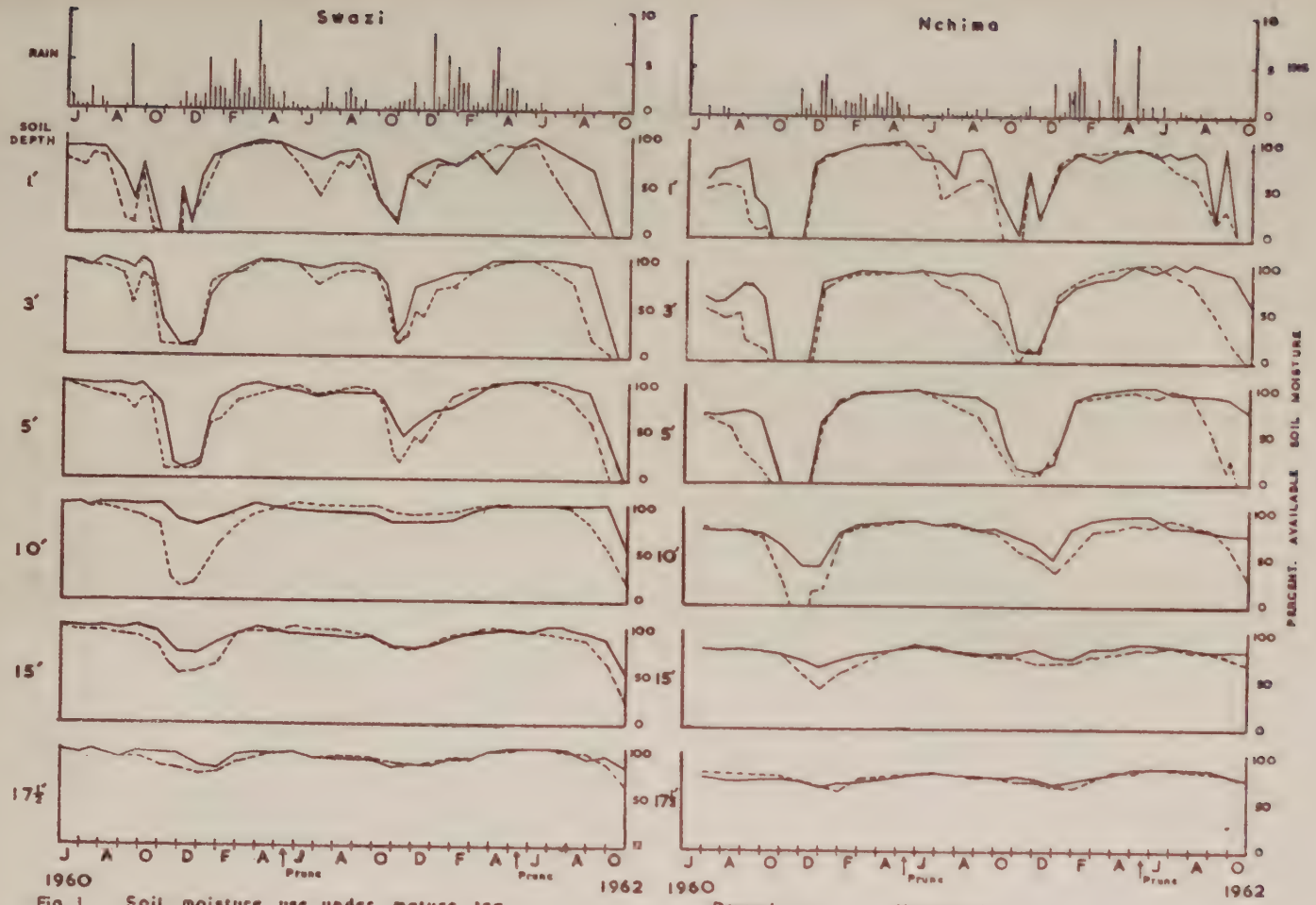


Fig. 1 Soil moisture use under mature tea

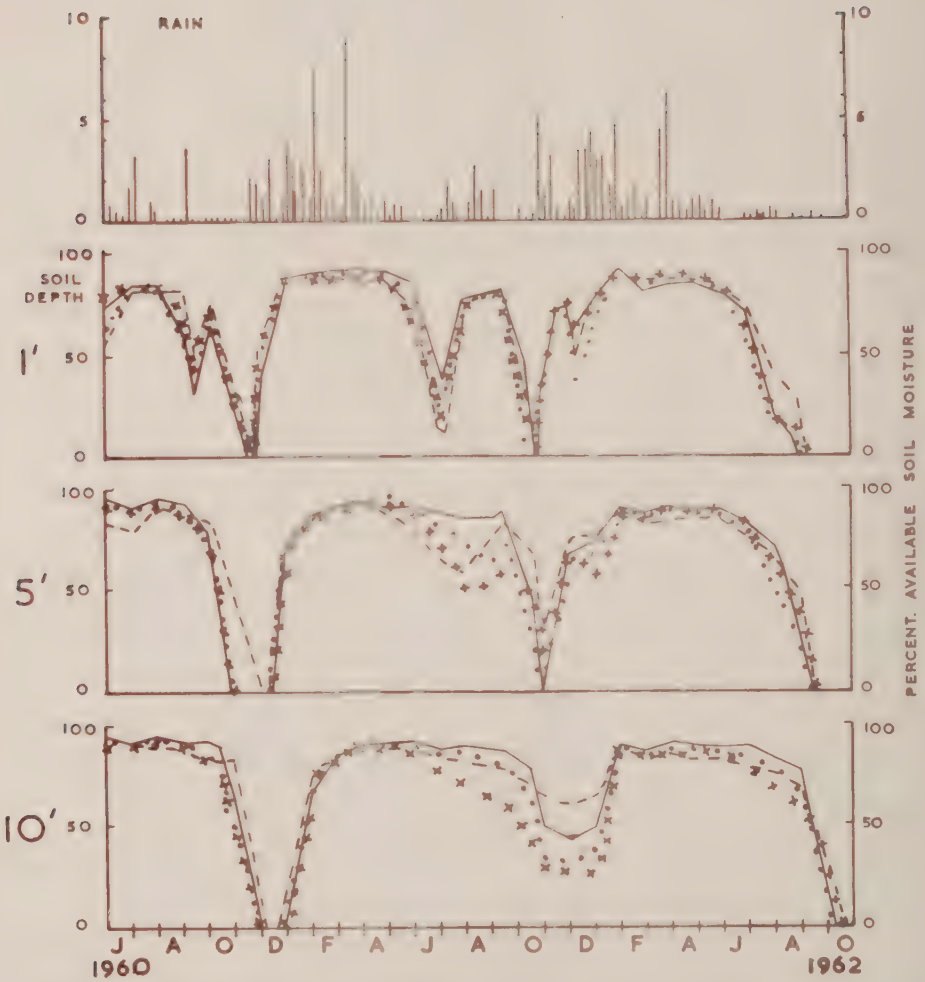


Fig. 2 Soil moisture use under tea with and without shade trees. No shade ——— Glyricidia – – – – Grevillea ····· Albizzia × × × ×

Because of the less congenial climatic conditions in the Cholo area, drying out at Ndima commences earlier and proceeds more rapidly, particularly under the unpruned tea, than at Swazi. The effect of the good dry season rains at Swazi during 1961 compared with the much poorer ones at Ndima are clearly seen. However the much closer similarity between drying out during the 1962 dry season can be ascribed to the fact that there was virtually no rain at either site over this period.

(ii) SOIL MOISTURE USE UNDER MATURE TEA WITH AND WITHOUT INTERPLANTED SHADE TREES, MIMOSA

As in previous seasons, readings of blocks placed at 1 foot, 5 feet and 10 feet depths under the four treatments of the shade tree experiment, were taken at weekly intervals.

Figure 2 shows changes in available moisture use from June, 1960, to October, 1962, under the main shade treatments, no shade, *Albizzia gummifera*, *Grevillea robusta* and *Glyricidia maculata*. Each entry in the figure is the average of 16 readings.

As before there seems to be little to indicate from the graphs that the significant differences found in yield between treatments can be related to changes in soil moisture status, the pattern of water use being more or less the same for all treatments during the 1962 dry season. It is thought therefore that reduction in yield under shade is probably not due to moisture competition or nutritional status, but rather to the shade effect *per se*, and would appear to be related to the density of the shade offered. (See more detail under the report of the Agronomy Section above.)

It is of interest to note that Figure 2 clearly emphasizes the importance of dry season rainfall and the marked effect it can have in delaying drying out of the soil profile.

(iii) WINDBREAK EXPERIMENTS AND SOIL MOISTURE STORAGE, MIMOSA

The experiment commenced in 1960, to study the effects on yield when tea is sheltered against wind, was continued. Block readings to a depth of 10 feet under the three treatments used, namely no shelter, netting as a shelter and netting plus sacking, have followed a pattern similar to that shown last season. Drying out occurred somewhat less rapidly where netting plus sacking was employed and this was particularly noticeable at depth. There was little to choose between the other two treatments.

Extract from Report of the Entomologist

Niphadolepis alianta, the Gelatine Grub, did not occur in pest proportions this season although the insect was recorded in a few places in Cholo and Mlanje. Nevertheless, the Gelatine Grub is still rather more numerous than is normal and outbreaks are possible in the next few seasons; estates have been asked to report any unusual activity or numbers of this insect. Control measures are necessary if ten or more grubs are found in a sample of twenty bushes.

Fifteen other pests of tea were recorded this season, but none was found causing any serious damage.

Cadra cautella Walk (the Dried Currant Moth) was discovered in London in tea from Nyasaland, but there is little doubt that the infestation was due to contamination from sources outside the country during the journey.

METEOROLOGICAL STATEMENT, MIMOSA, MLANJE DISTRICT, 1961/62 SEASON

Mimosa Station Latitude 16° 05 S., Longitude 35° 36 E., Elevation 2,140 ft.

Month	Rain in.	10 year mean in.	Max. °F	7 year mean °F	Min. °F	7 year mean °F	Thermograph mean daily °F Actual	Thermograph mean daily °F 10 yr. m.	Mean daily dew point °F Actual	Mean daily dew point °F 10 yr m.	Daily sun hours Actual	Daily sun hours 10 yr. m.	Wind m.p.d. Actual	Wind m.p.d. 7 yr m.	Penman Est. Eo in. Actual	Penman Est. Eo in. 7 yr. m.	Pan evaporation in. Actual	Pan evaporation in. 7 yr m
1961																		
July ..	2.92	1.51	73.5	74.1	56.3	52.6	63.2	62.3	57	53	4 6	6.1	59.52	58.03	3.19	3.51	3.58	3.67
August ..	4.96	1.50	75.7	78.5	55.1	54.3	63.9	64.9	56	53	6.0	7.3	53.52	62 12	4.09	4.57	4.02	4 67
September ..	1.58	1.58	83.9	84.0	57.7	58.6	69.9	69.2	57	55	8.7	7.3	67.60	72 49	5.85	5 58	6.25	6 06
October ..	5.93	2.06	88.2	89.0	62.5	62.3	74.2	75.2	61	58	8.2	8.7	66.94	76 79	7.04	7.37	6.34	8 09
November ..	5.85	6.91	84.5	88.3	64.4	65.1	72.8	75.7	65	63	6.1	7.6	64 95	72 57	6 24	7.28	5.45	8 02
December ..	9.25	9.79	84.0	85.2	65.5	66.3	73.7	74.0	66	67	5 6	5.8	56.61	58.68	6.29	6.39	6 73	5.62
1962																		
January ..	13.83	11.62	83.4	83.8	67.6	64.6	73.6	73.5	69	67	3.9	6.3	58 94	57.28	5.64	6.41	4.89	5.72
February ..	3.85	12.11	85.1	83.9	65.1	65.3	73.6	73.6	68	68	6.9	5.7	49.91	53 01	5 96	5 59	4.83	4.60
March ..	12.31	12.06	81.5	82.6	64.6	64.7	71.9	72.1	67	67	4.8	5.5	50.16	54 27	5.18	5.53	4.35	5.00
April ..	10 80	5.86	81.6	81.6	63.9	62.7	71.1	70 7	66	64	5.7	6.7	48 02	51 46	4.59	5 01	4.08	4.64
May ..	2.98	2.04	74.2	79.2	56.2	57.3	64.1	66.5	59	59	5.7	7.1	43.91	47 52	3.56	4.19	2.84	4.45
June ..	0.21	2.00	78.7	75.4	49.0	54.2	62.9	64.8	53	56	9.2	5.9	37.50	48 06	3.51	3.07	3.17	3.37
TOTAL ..	74.47	69.04	—	—	—	—	—	—	—	—	—	—	—	—	61.14	64.50	56.89	63.91

METEOROLOGICAL STATEMENT, CHOLO TEA RESEARCH STATION, CHOLO DISTRICT, 1961/62 SEASON

Cholo Station Latitude 16° 08′S., Longitude 35° 13 E., Elevation 2,960 ft.

Month	*Rain in.*	*3 year mean in.*	*Max. °F*	*2 year mean °F*	*Min. °F*	*2 year mean °F*	*Wind m.p.d.*		*Pan evaporation in.*	
							Actual	*2 year mean*	*Actual*	*2 year mean*
1961										
July	1.46	1.13	71.3	70.8	55.9	51.5	69.72	62.56	2.80	3.12
August	1.61	1.56	74.2	76.4	56.4	53.3	77.73	70.97	4.18	4.96
September	0.84	0.55	83.1	82.8	59.2	57.1	88.42	83.35	7.08	6.82
October	0.74	1.21	89.0	89.1	63.7	62.3	126.86	113.32	9.48	9.51
November	2.13	2.19	83.2	84.7	64.9	64.4	96.56	103.96	6.25	7.75
December	4.65	8.04	83.1	84.3	65.2	66.3	86.52	78.91	7.43	7.12
1962										
January	14.62	9.02	80.1	81.5	66.8	66.8	98.90	79.64	5.90	5.55
February	2.18	5.42	82.6	82.7	65.6	65.7	77.10	65.48	5.42	5.19
March	11.65	9.31	79.4	81.1	62.7	64.8	72.38	63.55	5.37	5.25
April	9.83	5.55	78.5	79.8	64.0	64.7	53.64	54.07	4.98	4.65
May	2.87	1.60	71.3	75.6	55.7	58.3	57.10	56.53	3.29	3.82
June	0.01	0.41	75.9	75.5	51.8	52.8	72.82	64.37	4.39	3.89
TOTALS	52.59	45.99	—	—	—	—	—	—	66.57	67.63

Abstract of Annual Report (1961/62) on Research into the Biochemistry of Tea Fermentation

by

D. S. Bendall and *R. P. F. Gregory*

In earlier reports we have described some of the main variable factors which determine the quality of the colour of a tea liquor and we have presented evidence that in this respect high quality bushes are not difficult to find in Nyasaland. An assessment of the *average* tea making potential of Nyasaland bushes would require analyses on a very large number. However, measurements which give information about the combined effects of tea-making potential of green leaf and of manufacturing methods have now been made on the liquors of made teas from a number of Nyasaland factories.

Measurements were made on the main grades from ten Nyasaland factories, and in one case on all the grades produced by the factory. The results, which are given in the following table, seem to be sufficiently consistent to make some valid generalizations about Nyasaland teas as a whole, but it would be desirable to have further data on teas from other countries to act as standards of comparison.

	Theaflavins %	*Thearubigins* %	*Thearubigins* E_{380}/E_{460}	*Total Colour* E_{460}	*Brightness* %
Chisambo BOP	0.71	13.4	5.16	3.52	17.3
Nchima BOP	0.64	13.5	5.90	3.09	17.4
Ruo BOP	0.63	12.6	5.58	3.04	17.7
Lujeri Fngs CTC	0.98	14.3	5.45	3.02	22.7
Lauderdale PF	0.74	13.3	5.41	3.39	18.6
Namingomba Fngs	0.84	13.8	5.64	3.59	20.7
Namingomba BOP	0.78	11.7	5.65	3.06	22.9
Makwasa BP	0.61	12.5	4.84	3.38	16.6
Makwasa BOP	0.77	14.0	4.75	3.79	16.3
Esperanza BOP	0.89	15.2	5.00	4.26	18.5
Likanga BPF	0.64	12.8	5.35	3.22	17.4
Swazi BP	0.73	10.1	5.31	2.75	22.7
BOP	0.76	11.3	5.52	3.11	21.5
BOPF	0.85	13.6	4.85	3.90	18.5
Fngs	0.74	11.6	5.15	3.29	19.2
Dust	0.84	13.2	4.81	3.85	18.7
Saosa Estate, Kenya BOP	0.92	14.9	5.30	3.99	20.2
BOPF	0.90	15.6	4.84	4.45	17.6
Lyons Red Label	1.18	14.6	4.77	4.35	25.0
Kenya Coffee Co. Assam tea (a very large leaf)	1.16	11.4	4.22	4.24	25.9
Ceylon tea	1.15	15.2	5.25	4.30	24.7

The contents of the two main classes of pigments, the theaflavins and thearubigins, are given as percentages of the weights of the made teas. Both pigments contribute to the total colour (depth of colour) of the liquor, but its brightness is determined largely by the proportion of the colour which is due to the theaflavins. Thus the figures for brightness represent the percentage of the total colour of the liquor which is due to the theaflavins. A careful examination of the figures shows that the total colour of the liquor is not determined entirely by the sum of the theaflavins and thearubigins. The thearubigins are a complex mixture of pigments and a given weight of some components may be more strongly coloured than the same weight of others. This property can be assessed by measuring the absorption by the solutions of light of two different wave-lengths (380 mμ and 460 mμ). The ratio E_{380}/E_{460} is related to the depth of colour of the thearubigins, and thearubigins with a deep colour have a relatively low value for this ratio.

The conclusions drawn from the figures are:

(i) In general the liquors have a low total colour, although the Esperanza sample is an exception.

(ii) Liquors are usually dull, although the Lujeri, Namingomba BOP and Swazi BP and BOP samples are fairly good in this respect.

(iii) Dullness is due to low theaflavin contents.

(iv) Weakness of the liquors (low total colour) is due partly to the relatively high E_{380}/E_{460} ratios and partly to the low theaflavin contents. A deficiency of thearubigins may contribute to a small extent in some cases.

The above results show that it is desirable to find means to increase the theaflavin contents of Nyasaland teas and to decrease the E_{380}/E_{460} ratio for the thearubigins. Previous work has shown that the former factor is related to the constitution of the green leaf as well as to the conditions of manufacture. There is little information available concerning the E_{380}/E_{460} ratio, but it may possibly be determined mainly by factory procedure. We hope that work which is in progress on the purification of both the polyphenol oxidase and the individual polyphenols from tea leaves will soon make a major contribution towards our understanding of these factors by enabling us to study the oxidation of pure polyphenols, individually and in mixture of various proportions, under the influence of the purified oxidase.

Analyses of theaflavin and thearubigin contents of made teas have assisted in the assessment of two field experiments, a shade experiment at Mabroukie Estate, Limuru, Kenya, and the N.P.K. trial at Swazi research station.

In the Mabroukie shade experiment, run by the East African Agriculture and Forestry Research Organization, teas were manufactured from plots under 50 per cent. shade and 15 per cent. shade respectively. We have been able to detect little difference in the made teas. The thearubigins appeared to be slightly higher in the tea from the 15 per cent. plot, but this was offset by an increase in the E_{380}/E_{460} ratio so that the total colour of the liquor was unaffected. There was no significant difference in the brightness of the liquors.

The samples from the N.P.K. experiment at Swazi were miniature-manufactured by the plant breeder. The results must be regarded as tentative, but there was a noticeable depression of the total colour of the liquor at the highest nitrogen level (120 lb. N./acre) compared with the lowest level (40 lb. N./acre). The weaker colour was due mainly to lower thearubigin contents. The effect on theaflavin content was variable and smaller; thus the liquors at the higher nitrogen levels, although weaker, were brighter. No definite effect on treatment with phosphate or potash emerged, although the results suggested that there may be optimum levels of application of each of these fertilizers. Although no definite conclusions can as yet be drawn, these observations and those which have been described by the plant breeder do promise that further work of this kind will be fruitful.

In continuing efforts to obtain the polyphenol oxidase in a pure state the enzyme has been found to combine very readily with the products of oxidation of the polyphenols (tannins) giving rise to brown tannin-enzyme complexes. Such tanning of the enzyme modifies its properties but does not inactivate it. In normal fermentation the enzyme probably becomes tanned at a very early stage, and we are proposing to investigate in more detail the way in which the properties of the enzyme are thus altered.

Most of the enzyme obtained from apparently green leaf has been in a tanned state, so that the immediate aim of obtaining the native enzyme in a pure state has been seriously hampered. The recent discovery of the reversal of tanning with substances such as triethylamine (which, incidentally, also prevents creaming down of a tea liquor), together with the use of freshly plucked leaf, should allow us to overcome this obstacle in the near future.

On the basis of these results, and also those described in earlier reports, we expect soon to be able to study the mechanism of fermentation in a reconstructed system, consisting of purified polyphenols and purified enzyme, in which the conditions can be accurately controlled and varied at will. We hope further to study the properties of the enzyme in green leaf and its behaviour during fermentation. Of crucial importance are the effects of the concentrations of oxygen and polyphenols on the rate of the reaction between them. In a model system the rate decreases as soon as the oxygen concentration falls a little below that of air, and in fermenting leaf the rate may be even more sensitive towards an inadequate supply of oxygen.

On a long-term view, the investigation of the formation and metabolism of polyphenols in the tea leaf and tea plant as a whole will be of fundamental importance. In a preliminary investigation, earlier observations of the distribution of polyphenols and oxidase in leaves of various ages have been extended to wood and bark and to young fibrous roots. Only the bark shows a significant capacity to ferment. The polyphenol contents of roots and wood are low, but that of bark approaches young leaves. However, although many of the individual polyphenols are present in both leaves and bark, the relative concentrations are markedly different in the two tissues.

Summary

1. The theaflavin and thearubigin contents of a number of Nyasaland teas have been determined. In most cases theaflavins were low, causing dull liquors. Thearubigins were fairly high, but were of a variety which is relatively weakly coloured.

2. Only small differences could be found between teas manufactured from shaded and unshaded plots in the Mal roukie shade experiment, Kenya.

3. Analyses on teas miniature-manufactured from the N.P.K. experiment at Swazi suggested that high levels of application of nitrogen depress thearubigin formation causing relatively bright, weak liquors.

4. Purification of the polyphenol oxidase from tea shoots has continued. The enzyme has been found to form very readily brown complexes with polyphenolic oxidation products, giving a modified but active enzyme. This "tanning" of the enzyme probably occurs early in fermentation. Means of dissociating some of the complexes have been found.

5. A study of the distribution of polyphenols and fermentability in bark, wood and roots of tea plants has shown that only bark possesses a concentration of polyphenols and ability to ferment which approaches that of leaves, but the pattern of polyphenols is markedly different in the two tissues.

TUNG

Owing to staff shortage it has not been possible to prepare a report on the agronomic experiments but the results have all been recorded and will be reported next year.

Extract from Report of the Senior Agricultural Chemist

STATUTORY ANALYSES OF EXPORTED OIL

Prices have continued to increase, and this has caused all available seed to be sent for processing. Last season's total of 1,232 tons has been exceeded, the total for the 1961/62 crop being 1,368 tons. This is a noteworthy increase, if one is to consider the biennial bearing factor, as the figure two seasons ago was 1,093 tons. The distribution of exports is summarized below:

Africa	*U.K.*	*Europe (not U.K.)*	*Asia*	*U.S.A.*	*Australia*	
498 ..	429 ..	214 ..	145 ..	81 ..	1	tons
36 ..	31 ..	16 ..	11 ..	6 ..	—	% of whole

As major importers the U.K. and African territories now consume about the same amount. The two Southern Province factories produced 523 and 416 tons while that in the Northern Province almost doubled the previous year's output by reaching the figure of 429 tons. The amount of oil from *Aleurites fordii* decreases each year and this season totalled only six tons.

COMPOSITION OF TUNG OIL

The season has been noteworthy for dry atmospheric conditions during the months of expelling. This was especially so in the Northern Province, where damp conditions have always been a problem, for example, towards the end of the 1960/61 crop, some seed contained oil of up to 20 per cent. F.F.A. At the end of last season an investigation, involving some 80 samples, was carried out to resolve the practicability of mechanical dehulling and subsequent drying in an attempt to overcome this problem of moisture control during seed storage. The better conditions this season are reflected in the very low range of acidities of the oil, about 90 per cent. of the exports having a free fatty acid content of less than 1.0 per cent., and only in 2 per cent. of the production was the figure over 1.5 per cent. The maximum acidity at the Southern Province factories was 1.7 and 1.0 per cent., and in the North, a maximum figure of 1.0 per cent. was obtained. This improvement was also seen in the lower gelation times obtained, the maximum in the Southern Province oil being 22½ minutes, while the corresponding figure for the North was 24 minutes.

UTILIZATION OF TUNG OIL

The programme of research carried out by Dr. Chatfield has confirmed the value of *montana* oil in increasing the life of emulsion paints. A further investigation has shown how media based on tall oil alkyds can be enhanced in durability by reinforcement with *montana* tung oil.

COFFEE

Owing to staff shortage it has not been possible to prepare a report on the agronomic experiments but the results have all been recorded and will be reported next year.

Fusarium Scheme

OBSERVATIONS IN THE FIELD

It has been maintained in the past that adherence to the rules of good husbandry in coffee culture will control the diseases due to *F. stilboides*. A variety trial on the Tung Station, now 6 years old, has 7% of the trees infected. This trial has been well looked after and the level of infection compares very favourably with other coffee of comparable age in the same area, some of which may be 100% infected. It is felt that this substantiates the claims made that *F. stilboides* was a weak pathogen affecting coffee growing in debilitating circumstances which could be controlled by growing the coffee well.

PHYSIOLOGY OF THE FUNGUS

One aspect of the etiology of this disease which has not been reported previously is the effect of soil pH on development of symptoms. Two trials have been designed to investigate this. One is a field trial laid out in a heavily infected field on an estate (by courtesy of the management of Nyasa Tea Estates Ltd.) and the other is a greenhouse trial. Results of these trials are not yet available. A range of soil pH values has been obtained by application of appropriate amounts of sulphur or lime.

FUNGICIDAL CONTROL

In view of the decidedly uneconomic character and doubtful efficacy of fungicides in the control of these diseases, all fungicide trials have now been discontinued. All further experiments on control will be on the selection of resistant varieties.

RESISTANT VARIETIES

An extensive series of inoculations has been undertaken in the greenhouse in order to find a range of varieties resistant to the diseases. Using an arbitrary criterion of resistance following inoculation at a leaf scar a number of varieties apparently resistant to *F. stilboides* has been discovered. (For techniques used, *see* last year's report.) These have been planted out in a field trial which is due to be inoculated next year.

The performance of the 12 best Arabica varieties is given below compared to the percentage of those free of symptoms in an infected field. The coffee plants inoculated in the greenhouse trial were 9 months old at inoculation and the coffee in the field trial was 6 years old when the observations reported here were made.

Varieties	*Greenhouse trial Resistance expressed as %*	*Field trial Resistance expressed as % symptom-free*
1. S.L. 14	100	100
2. S.L. 34	100	95.9
3. Caturra	100	Not available
4. Dilla and Alghe	100	100
5. K. 7	80	87.5
6. N. 5	80	91.7
7. Brazil	80	Not available
8. K.P. 228	80	83.3
9. S.L. 6	80	95.9
10. K.P. 128	80	100
11. K.P. 423	80	91.7
12. N. 81	80	87.5

These results should only be taken as an indication at this stage. The reason for this is two-fold: (1) conditions in the greenhouse bear little relation to conditions in the field, and (2) the field in which the observations of % freedom from the disease was made is a normal variety trial in which no inoculations were made. It is hoped to obtain evidence corroborating these results from the field trial due to be inoculated next year.

PUBLICATION

A paper describing the symptoms of the complex of diseases caused by *F. stilboides* and giving a full description of the fungus, the first in a projected series of three papers, has been accepted for publication by the British Mycological Society in their Transactions. (cf. report of the Plant Pathologist under "Publications".)

Extract from Report of the Senior Agricultural Chemist

FUSARIUM INVESTIGATIONS—LIMING TRIAL

In December, 1962, almost three years after the commencement of this trial, the pH of the plots was as follows:—

	Control	*S/A*	*Urea*	*CAN*	*Lime*
0–6" ..	6.0	5.4	5.6	5.7	8.0
12–18" ..	5.3	4.9	5.2	5.1	5.8
24–30" ..	5.2	4.9	4.9	4.9	5.2

These figures are the mean of ten samples; duplicate samples being taken halfway between the stem and the maximum spread of the bush, on five bushes for each treatment. It is interesting to note the rather limited effect of the treatments below 12 inches.

An associated pot experiment was concluded, and the mean of 40 pots for each treatment is summarized as follows:—

		0–1"	4–6"
	Initial pH of soil		5.6
I	Cattle manure only, each month	6.2	6.1
II	4 oz. lime added, then as I, but +1 gm. lime	7.1	6.8
III	8 oz. lime added, then as I, but +2 gm. lime	7.5	6.9
IV	12 oz. lime added, then as I, but +4 gm. lime	7.6	7.4

These changes had occurred one year after the commencement of the experiment.

Extract from Report of the Soil Physicist

SOIL MOSTURE USE UNDER IRRIGATED COFFEE, BVUMBWE

Twice-weekly readings were continued throughout the year on three replicate profiles of gypsum blocks installed at foot intervals to a depth of ten feet under each of the five coffee irrigation treatments at Bvumbwe. These are as follows:—

1. Control—no irrigation.
2. Irrigate maturing crop only, i.e. to August.
3. Irrigate during flowering period only, i.e. September onwards.
4. Irrigate during maturing and flowering.
5. Irrigate monthly, if required.

To check the amount of water required for irrigation, gravimetric soil moisture determinations were made periodically to rooting depth, though lack of labour delayed this work considerably during the 1962 dry season, and in consequence available moisture in the profiles fell well below the three-quarters field capacity level before being replenished. The calculated quantity of water required to restore the various treatments to field capacity was metered onto four foot square basins around the trees.

Changes in moisture status as from April, 1961, to October, 1962, to a depth of eight feet under all treatments, together with the amount of irrigation water applied in gallons per tree are presented graphically in Fig. 1. The effect of the poor dry season rains in 1962 (2.39 in. from June–October) on soil moisture use is very noticeable under all treatments, depths of up to eight feet being tapped, and contrasts strongly with that during the same period in 1961 (4.93 in. from June–October). The delay in irrigation in 1962 accounts for the strong similarity between patterns of drying out in all profiles and emphasizes the need for regular gravimetric measurement and application of irrigation water at the correct time. When irrigation was eventually applied in September, 1962, to those treatments requiring it, the effects on the available soil moisture were immediately apparent.

Where water was applied correctly to the treatments as in the 1961 season the effects on the various moisture profiles are clearly seen. The greatest drying out occurred as expected where no irrigation took place. Irrigation of the maturing crop only, maintained the soil moisture level until the crop had been harvested, after which it declined when irrigation ceased. On the other hand when irrigation was delayed until flowering, the profile dried rapidly to depth until it was subsequently refilled. A combination of both these treatments maintains soil moisture at a reasonable level throughout the dry season as does monthly irrigation.

Examination of the yield data for the 1962 crop, presented in Table I, indicates the importance of irrigating the crop while maturing rather than at any other time. Marked increases in yield have been obtained for comparatively small applications of water.

TABLE I

Yield Data, Irrigated Coffee, Bvumbwe, 1962

mean of three replications

	Irrigation treatments	*Mean yield lb. clean Coffee per acre*
1.	Control—no irrigation	3,230
2.	Maturing crop only	**3,720
3.	Flowering period only	2,953
4.	During maturing and flowering ..	**3,724
5.	Monthly as required	*3,475
	L.S.D. P=0.05	367
	P=0.01	533
	Coefficient of Variation	7.34%

Extract from Report of the Entomologist

Habrochila sp. (Tingidae) was recorded from several areas where sub-standard coffee cultivation occurred. Damage was rarely noticeable.

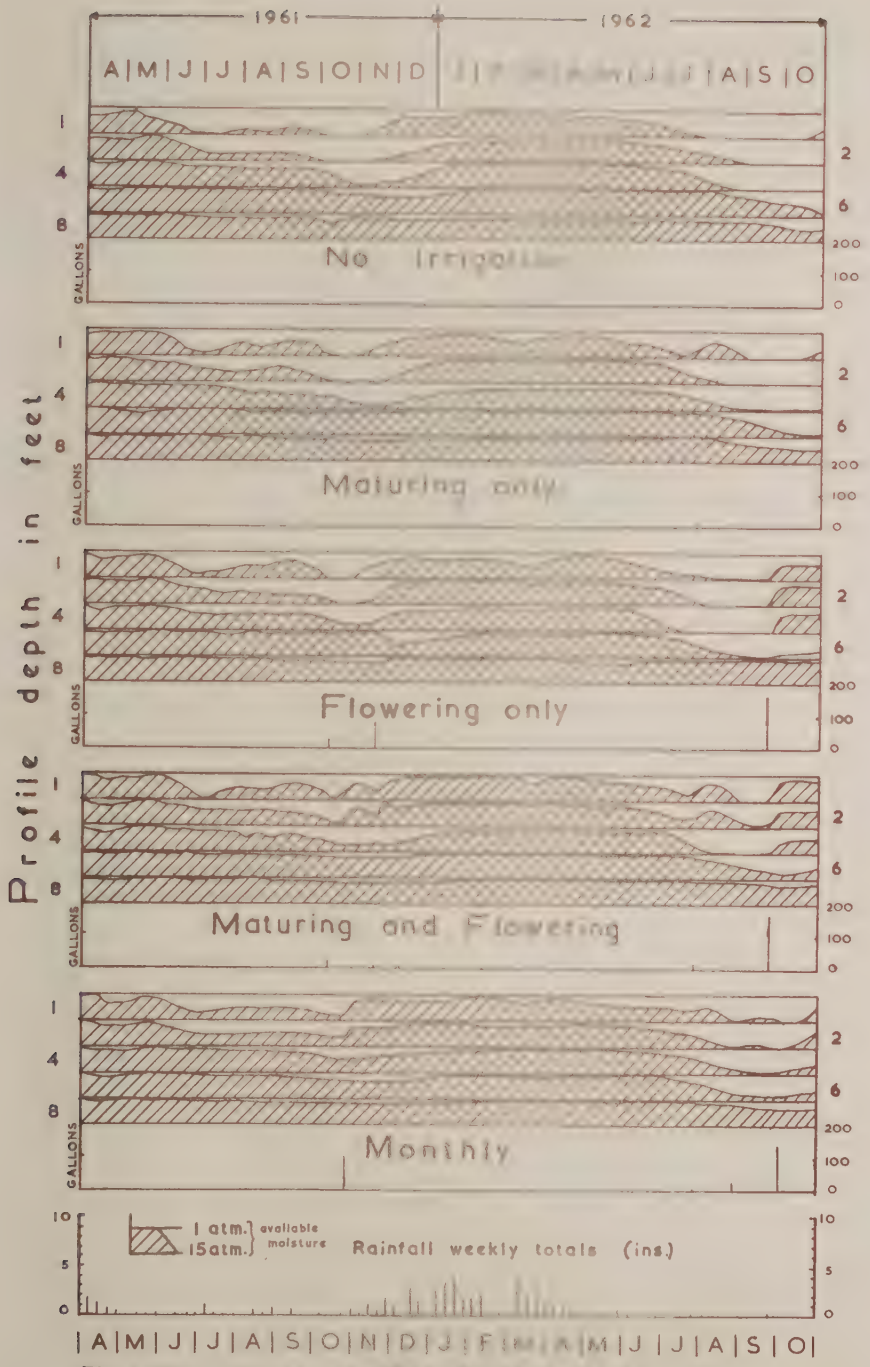


Fig. 1. Soil moisture distribution under five coffee irrigation treatments, Bvumbwe

Leucoptera coffeela caused rather more damage than usual this season and appears to be increasing, although severe damage was local. This species was considerably more common than *L. caffeina*, although the latter species was also recorded. Diazinon gives control of both species, but 50% malathion miscible at the rate of one fluid ounce in two gallons of water with a second application after ten days has given a higher control in Nyasaland if the first application is made when the moths emerge in November/December.

Thriptoceras octoguttale (Coffee Berry Moth) caused some considerable damage to coffee in the Kirk Range in May. Some coffee gardens were severely attacked with almost total loss of berries on some bushes, and every garden examined had some damage. This insect was rare elsewhere.

Thrips caused some damage in uncared for gardens in Zomba District, as did *Anthores leuconotus*. Only one specimen of *Dirphya nigricollis* was recorded this season in Zomba District.

The commonest fruit-flies on coffee were *Trirhithrum nigerrimum* Bezzi, *Zaprionus vittiger* Coq., and *Z. tuberculatus* Malloch. Damage to the ripening berries was nowhere found to have caused any serious damage, however, although some discoloration of the parchment occurred. *Pardalaspis cosyra* Walk. was also recorded on one occasion.

SUGAR

Introduction

Since little has been reported before on the history of this crop at Makanga a few notes here are not inappropriate. In January, 1955, the first twenty varieties were brought to Makanga from Alimenda and later in the year a further six varieties were brought from the same source. These twenty-two varieties were planted in a museum plot of .38 acres in size. Observations on growth, flowering times and general suitability were made but no formal experiments were laid down until 1960. In December, 1959, a further seven varieties were imported, a small number of setts of each variety being obtained from both Kenya and Tanganyika. Recently in April, 1962, two additional varieties from Southern Rhodesia were obtained making the total number of varieties now under observation thirty-one.

Variety Trials

The first formal variety trial was laid down in May, 1960, to test the performance of nine of the most promising of the first introductions. The trial, a 3×3 balanced lattice of four replications, was planted with two node setts at a spacing of 1 ft. between sett ends the rows being 5 ft. apart. Gross plots were .031 acres, net harvested plots .009 acres. The material used, fourth ratoon cane, was not ideal for planting and establishment was variable. Termite attacks on germinating setts also reduced the stand.

Subsequent growth was good and the crop was cut in July, 1961, at the age of fourteen months. Table I summarizes the yield data.

TABLE I

Harvesting Data Sugar Cane Variety Trial, Makanga

Variety	*Yield tons cane/acre*	*Stools cane/acre*	*O Brix*
CO419	57.2	3,090	15.9
POJ2878	50.2	2,820	18.0
CO464	49.7	3,420	15.8
CO331	49.5	3,420	16.7
CP34/120	44.1	3,330	17.4
CO310	42.3	3,200	16.4
B3337	41.2	2,610	16.5
CO301	37.7	2,310	17.4
CO290	36.0	2,790	16.5
L.S.D. 5%	9.86		
,, 1%	13.17		
Coefficient of Variation	18.8%		

Since there was no control variety the order of yields (Duncan's Multiple range test 5% level) is given below.

A	B	C	D	E	F	G	H	I
CO419	POJ2878	CO464	CO331	CP341 120	NCO310	B3337	CO301	CO290
57.2	50.2	49.7	49.5	44.1	42.3	41.2	37.7	36.0

WATER RATES TRIAL

Three water rate treatments were superimposed on blocks in each replication on the previous trial and were:—

Treatment A	Irrigation Factor	.6× Ev.	O. pan
.. B	,,	,,	1.0× ,,	,,
,, C	,,	,,	1.4× ..	..

More details will be given in another part of this report but Table II summarizes the main effects.

TABLE II

Harvesting Data Water Rate Trial, Sugar Cane, Makanga

Factor	*Yield tons cane/acre*	*Stools cane/acre*
.6 Ev. O. pan	40.01	2,869
1.0 ,, ,, ...	47.72	2,842
1.4 ,, ,, ...	45.60	2,878
L.S.D. 5%	4.54	
,, 1%	7.7	
Coefficient of Variation	11.1%	

NITROGEN TRIAL

In a further two similar replications each containing the same nine varieties three nitrogen treatments were superimposed on blocks in each replication The treatments were:—

N_0 Control
N_1 100 lb. Sulphate of Ammonia/acre
N_2 200 lb. Sulphate of Ammonia/acre

Nitrogen gave no significant responses. Table III shows the results.

TABLE III

Harvesting Data, Nitrogen Trial, Sugar Cane, Makanga

Treatment	*Yield tons cane/acre*	*Stools cane/acre*
N_0	46.66	3,666
N_1	44.01	3,684
N_2	50.53	3,557
Mean	47.10	—
L.S.D. 5%	19.6	—
Coefficient of Variation	29%	—

The mean yield of all varieties in these three trials was 44.4 tons cane/acre at 14 months or 3.17 tons cane per month.

VARIETY BULKING AND OBSERVATION TRIAL

In September, 1960, a further observation and bulking trial was laid down to provide planting material of a comparable age of the nine best older and the seven newer introductions. This was laid out in a 4 × 4 balanced lattice of 5 replications with a view to later comparing yields of ratoon crops. A unit plot was one single row of cane and it soon became obvious that competition between varieties would in many cases mask yield differences. The trial also suffered from serious pilfering so when harvested in November, 1961, at 14 months, few conclusions could be drawn. The varieties CO617, CO513, CO622, CP34-120, CO331 and POJ2878 did however show good growth throughout and looked the most promising.

FIRST RATOON HARVEST VARIETY, WATER RATE AND NITROGEN TRIALS

The first ratoon crop in these three trials (plant cane harvested July, 1961) made good growth until mid March when strong winds caused severe lodging in all three trials. Thereafter irrigation was difficult owing to the laid cane blocking the inter-row spaces. Water applications were then made at 4-inch, instead of the normal 2-inch deficits to regulate water distribution. Many ball shoots began to appear and four of the varieties were arrowing profusely. Though preliminary brix sampling had indicated that the crop had not quite reached maturity nonetheless the general state of the crop and the decision already taken to replant these trials on an improved layout in the light of more recent findings, made the harvesting of this crop at 11 months the best course. Harvesting was carried out during June, 1962.

VARIETY TRIAL, FIRST RATOON

Despite the short growing season yields were very satisfactory but due to the late rains maturity was delayed though irrigation was stopped at the beginning of May. Brix readings show that some varieties would have increased in sugar content if left standing for at least another month. Yields showed less variation than in the plant cane crop there being no significant differences. Table IV summarizes the yields and data.

TABLE IV

Harvesting Data, First Ratoon, Cane variety trial, Makanga

Variety	*Yield tons cane/acre*	*Stools can /acre*	*O Brix*
CO331	43.0	3,760	14.6
CO419	42.7	2,560	15.9
CO290	40.7	2,450	16.1
CO301	39.9	3,290	14.7
CP34/120	39.8	3,490	16.6
POJ2878	39.5	2,970	15.2
B3337	38.4	3,080	16.6
CO464	37.7	3,620	13.9
N: CO310	36.6	3,350	16.4
Mean	39.8	—	—
L.S.D. 5%	9.5	—	—
C. of V.	14.6%	—	—

WATER RATES TRIAL, FIRST RATOON

The water rates trial begun on the plant cane was continued throughout the first ratoon crop. Again this will be reported in more detail elsewhere but the main effects are given in Table V

TABLE V

Harvesting Data

Water Rate Trial, First Ratoon Cane, Makanga

Factor	*Yield tons cane/acre*	*Stools cane/acre*
.6 Ev. Open pan	35.5	3.04
1.0 Ev. Open pan	42.7	3.31
1.4 Ev. Open pan	38.3	3.17
L.S.D. 5%	4.8	—
1%	7.3	—

NITROGEN FERTILIZER TRIAL, FIRST RATOON

Plant population as in the previous year was better in this trial than in the Variety and Water Rate Trial and harvesting was carried out at the end of June. Table VI summarizes harvesting data, again there was no significant response to nitrogen fertilizer.

TABLE VI

Harvesting Data, Nitrogen Fertilizer Trial, First Ratoon Cane, Makanga

Treatment lb. Sulphate of Ammonia/acre	*Yield tons cane/acre*	*Stools cane/acre*
Nil	49.3	3.92
100	42.4	3 68
200	48.5	3.44
Mean	46.7	—
L.S.D. 5%	9.5	—
Coefficient of Variation	14.2%	—

In these three first ratoon trials the mean yield was 41.5 tons cane/acre at 11 months or 3.77 tons cane/month a higher yield of cane per month than that obtained from the plant crop.

Irrigation Studies—Sugar Cane

WATER RATES, PRELIMINARY OBSERVATIONS

The first gypsum resistance blocks were placed in a sugar cane trial towards the end of 1960, blocks being placed in the profile at the 1, 2, 4 and 6 feet levels. This trial was irrigated at three water rates: .6E open pan, 1.0E open pan and 1.4E open pan these factors being applied after a full canopy had formed, i.e. about 3½ months from planting. Irrigations were applied when a calculated deficit of 2 in. was shown on the water balance sheet for the trial. Soil moisture readings were taken from February until harvesting in mid-July which period corresponded with the eighth to the fourteenth month of the crop.

A study of the graphs showing the moisture status of the profile at the various levels under the three irrigation factors showed:—

(*a*) Only the factor $1.4E_0$ maintained the top 2 ft. of profile at or close to field capacity throughout the period. Irrigations ceased seven weeks before harvest. The top foot of soil was dried out to wilting point but the next foot still retained a high moisture content up to harvesting. Below the two-feet level soil moisture remained at or near field capacity.

(*b*) The factor of $1.0E_0$ was insufficient to keep the top two feet of soil approaching field capacity except immediately after irrigations. Four- and six-feet blocks showed that water was also being drawn by the crop from these levels. At harvesting soils in the top four feet were dried to nearly wilting point.

(*c*) The same picture was shown by the factor $0.6E_0$ except that water stress in the top 1 foot was more frequent and severe and utilization of water at the 4 and 6 feet level was higher than in the previous treatment. At harvesting the profile was dried out to below the 4 feet level.

The summary of data in Table VII shows that the highest yield was obtained using an irrigation factor of $1.0E_0$. This treatment produced higher yields than either of the other two factors, significantly higher than the factor $0.6E_0$.

TABLE VII

Summary of Data—Sugar Cane Water Rates Trial, Makanga

(1) *Irrigation factor*	(2) *Yield tons cane/acre*	(3) *Inches rainfall May 60 June 61*	(4) *In. water applied May 60 May 61*	(3) + (4)	*Inches Evaporation May 60 June 61*
.6E Open Pan .. .	40.0	28.59	25	53.59	100.8
1.0E ,, ,, ...	47.7	28.59	51	79.59	100.8
1.4E ,, ,, ...	45.6	28.59	78	106.59	100.8
L.S.D. 5%	4.5	—	—	—	—
L.S.D. 1%	7.7	—	—	—	—
Coefficient of Variation ..	11.1%	—	—	—	—

WATER RATES, FIRST RATOON CROP

The same water rates trial was continued in the first ratoon crop, treatments (irrigation factors) remaining the same, i.e. $0.6E_0$, $1.0E_0$, $1.4E_0$. Four inches water was applied overall in mid-August after post-harvesting cultivations. Thereafter until the full factors were applied in the first week of November half rates, i.e. $.3E_0$, $.5E_0$, $.7E_0$, were used on the young cane. Additional gypsum blocks were placed at the 8 and 10 feet levels and nylon blocks were inserted at the 9-inch level.

The pattern of water use followed closely on that exhibited by the plant cane. Weekly soil moisture readings were recorded and Fig. 1 shows the mean fortnightly soil moisture content at the various levels in the main rooting zone of the crop. It will be noted that the profile under the $1.4E_0$ treatment contained much more moisture than the profiles under the other two treatments at the start of recording. This was obviously a carry over of excess moisture from the previous year's irrigation.

In mid-December the rains started and during January rainfall far exceeded each and all theoretical irrigation factors. The result was that the profiles in the two lower rates of irrigation filled up during this period. In mid-April as the rains tapered off only irrigation at the two higher factors maintained the first four feet of rooting zone with adequate moisture for good growth.

GROWTH RATES

Twenty canes in each irrigation treatment were selected at random for growth rate measurement, heights being recorded from 8th October to 12th March when the crop was severely laid and no further measurements were possible. Heights were recorded thrice weekly and histograms of growth rates prepared. These showed clearly

FIGURE 1.

EFFECT OF VARIOUS IRRIGATION RATES ON SOIL MOISTURE UNDER SUGAR CANE

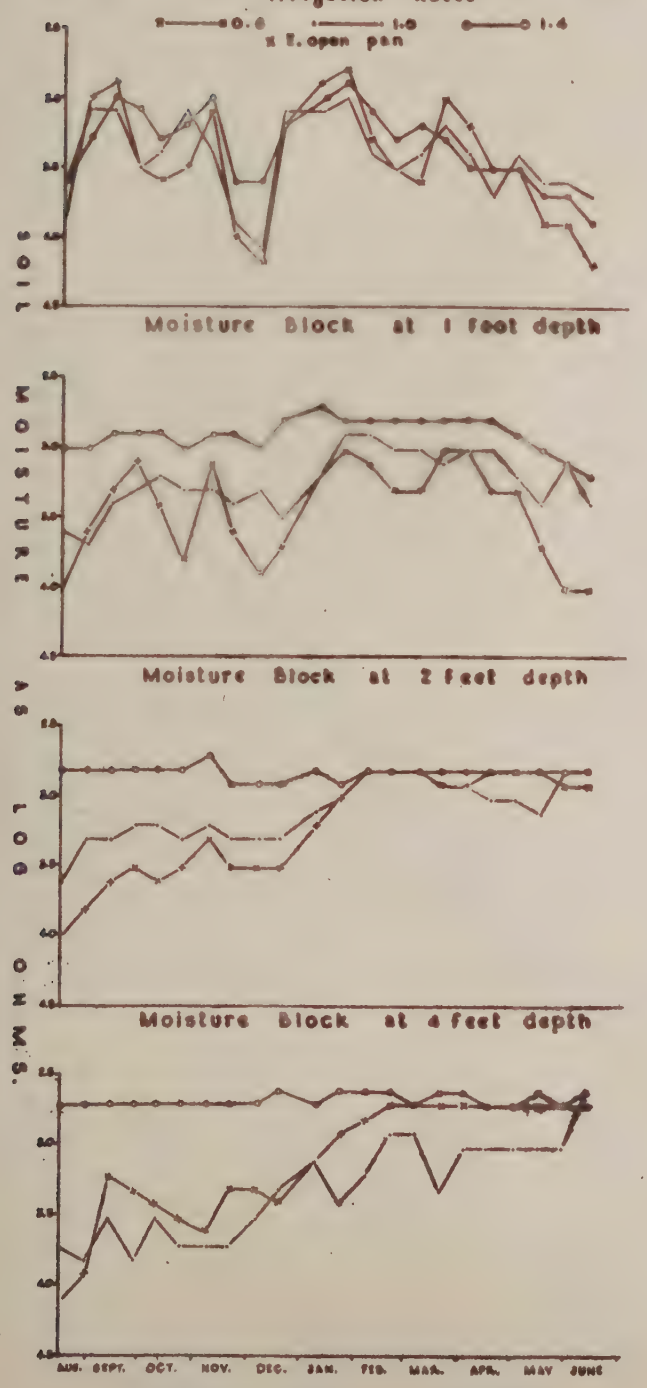
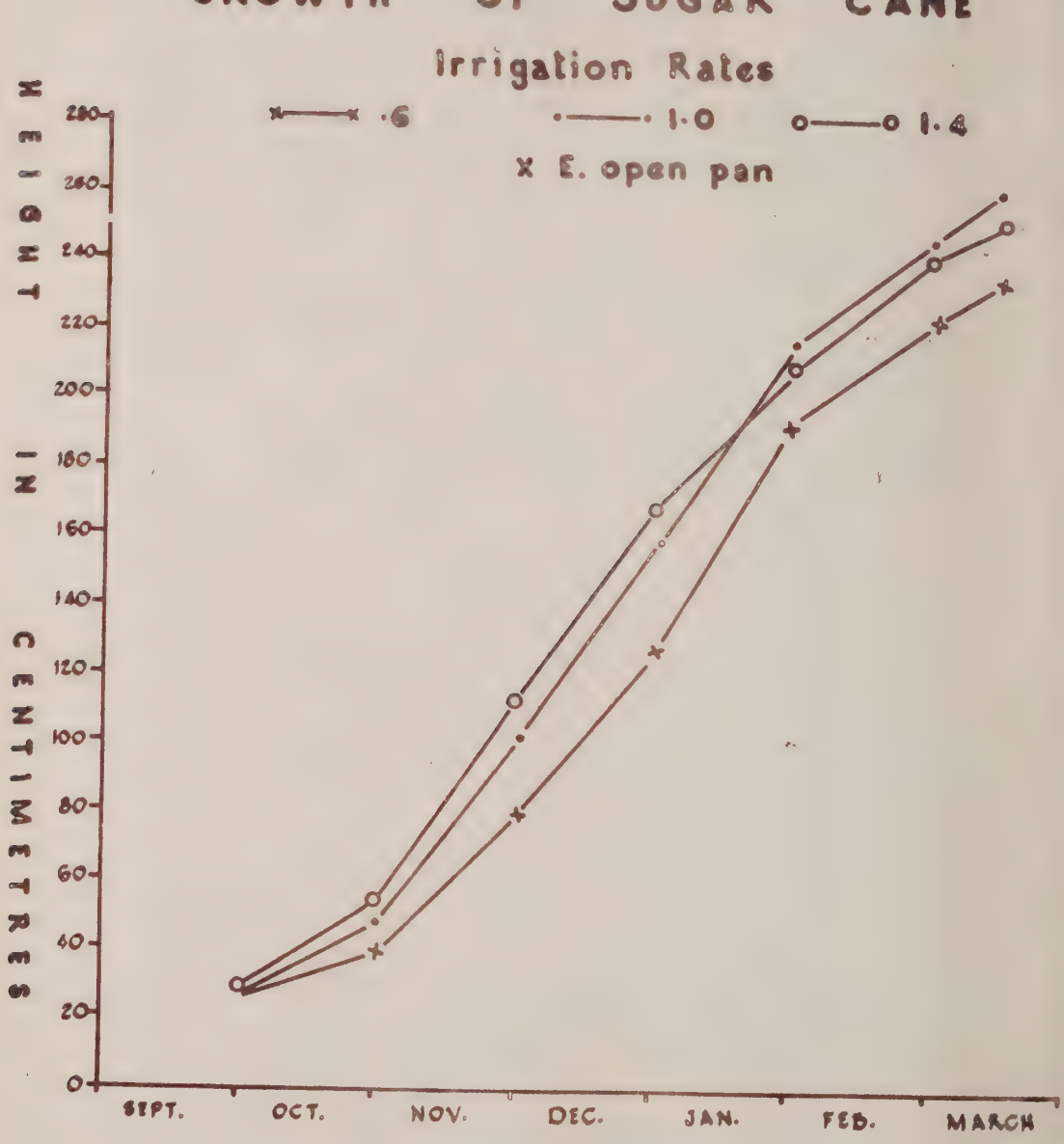


FIGURE II

GROWTH OF SUGAR CANE



that during the period of high evaporation in October, November and early December even the high irrigation factor of $1.4E_0$ was insufficient to prevent a reduction of growth rate due to moisture stress particularly in the two weeks preceeding the onset of the rains in December. With the advent of conditions of low evaporation and high precipitation a different picture emerged, growth rates under the lower irrigation rates rapidly increasing. The lowest factor $.6E_0$ showed a reduction in growth rate during the dry February and March period but growth under the higher factors remained good. Fig. 2 shows relative growth rates over the period.

The yield and relevant data are given in Table VIII.

TABLE VIII

Summary of Data—Sugar Cane Water Rates Trial, First Ratoon Crop, Makanga

Irrigation factor	(1) *Yield cane tons/acre*	(2) *Inches rainfall Aug. 61–May 62*	(3) *Ins water applied Aug. 61–May 62*	(2)+(3)	*Inches Evaporation Aug. 61–May 62*
$0.6E_0$	35.5	35.8	24.0	59.8	75.74
$1.0E_0$	42.7	35.8	40.0	75.8	75.74
$1.4E_0$	38.3	35.8	54.0	89.8	75.74

L.S.D. 5% 4.8
L.S.D. 1% 7.3
Coefficient of Variation .. 21.6%

DISCUSSION

These observations and trials were of a preliminary nature and are open to criticism, particularly as at the beginning of the first ratoon crop soil moisture status in the rooting zone was not the same in all treatments. Findings indicate that while sugar cane can and does draw moisture from considerable depths the moisture status in the first two feet of profile has the greatest influence on growth rate. When the period of maximum cane elongation, i.e. from the fourth to the twelfth month, coincides with a period of maximum evaporation, high temperatures, and low precipitation then an irrigation factor of at least $1.4 \times E$ Open Pan is required to ensure continuous growth of the crop. On the other hand if the profile is filled up prior to the onset of heavy rains water-logging and reduced growth rates ensue.

COCOA

(a) At Makanga

GROWTH

Growth throughout the year was very good and many of the earlier abnormal leaf conditions have now disappeared. The younger trees were flowering profusely at the end of the year and the older trees showed a big increase in yield during the year. Because of the pruning of all leading chupons in previous years many of the trees may well remain of the one-storey habit but leading chupons are now appearing and one on each tree is now being allowed to remain. This should give a more natural form to these trees and with the longer main stem encourage production of pods on the main stem as is normal rather than on the fan branches. In the one-storeyed trees an appreciable number of branches sagged and broke under the load of pods particularly on trees at the edges of the plot. It is felt that in the very fertile conditions existing the spacing of the trees should have been closer, 8 ft. by 8 ft. instead of the existing 10 ft. by 10 ft. This, it is believed, would have encouraged more rapid upward growth and the earlier formation of a closed canopy. The present excessive side growth of the first branches of the first jorquette and the bearing of pods on these branches is making harvesting extremely difficult.

PRODUCTION

During the year all the trees planted during December, 1957, and January, 1958, were in bearing, the Amelonado and Trinitario types giving their first appreciable harvest, while the production of the Amazon types was increasing rapidly. Table I shows the basic harvesting data.

TABLE I

Harvesting Data, May, 1961–April, 1962

Type	*Variety*	*No. of trees*	*Yield in lb. dry beans/ acre*	*Percentage of total pods damaged*
Upper Amazon	T 79	21	1,056	20
	T 73	40	972	23
	NA/PA	16	523	17
	T 17	15	1,220	16
Trinitario	T 9	5	400	44
Trinitario Hybrids	R 15	17	553	26
	SC 4	6	109	3
Amelonado	A 196	8	245	22
	S 84	14	283	37
New Hybrid, 2nd Generation	WEA 2	5	375	45

The yield figures represent only the good beans harvested, all pods in which one third or more of the beans were damaged from any cause were discarded. The high percentage of damaged pods in varieties WEA 2, S 84 and T 9 was caused by germinated beans. Great difficulty was experienced in knowing when the pods of these varieties were ripe as the normal colour change at maturity was frequently absent and consequently pods were often over ripe at harvesting and the beans had begun to germinate.

The second greatest contributory factor to damaged pods was scorching by direct sunlight and this caused rapid decay of pods so exposed. Pods were exposed to direct sunlight when branches sagged under the heavy load of fruit thus opening the canopy and destroying the normal shade produced by the canopy. Initial damage from fungal attacks was slight. In a variety like T 79 where the four plots are situated along one edge of the field the sagging and breaking of branches resulted in a considerable percentage of pods being exposed to direct sunlight and hence increased the percentage of damaged pods.

As harvesting knowledge and technique improve it should be possible to reduce the percentage of damaged pods.

PRODUCTION PATTERN AND FREQUENCY OF HARVESTING

Although it is possible to pick a few ripe pods any month in the year the main harvest was taken between late November and early March with peak production in January. A small "second crop" was harvested in July/August. Harvesting at every two to three weeks is necessary, the shorter interval being necessary at peak production in January when temperatures and humidity are high and the incidence of germination of beans in the pod appears to be greatest.

FERMENTATION

A number of fermentations were tried but in all cases the quantity of beans, never more than 100 lb., proved too small to induce sufficiently high temperatures in the fermenting mass. The result was that all batches contained a high percentage of partially fermented beans, too high a percentage to satisfy the manufacturer. However since it is generally accepted that quantities of wet beans of 400–600 lb. are necessary to ensure good fermentation, except in controlled laboratory conditions, the results were not discouraging and some knowledge of fermentation techniques and drying have been acquired by the field personnel. Next harvest it is anticipated that there will be sufficient beans at least during peak production to carry out further fermentation trials. The out-turn of dry beans from wet beans averaged 36.7 per cent. from five fermentations during the peak production period in January and February, a slight improvement on last year's figures. The average dry bean weight for the same period was .84 grammes, still lower than desirable but an improvement on the previous year.

PESTS AND DISEASES

The incidence of pests and diseases was very slight and at no time during the year warranted the use of any curative treatment. Mechanical damage by strong arid winds in September and October caused considerable leaf shed on exposed trees. Strong winds accompanied by rain were a further contributory cause to the sagging and breaking of heavily-laden branches.

IRRIGATION

Treatments introducing variations in the irrigation regime have been applied since November, 1960, with a view to ascertaining the water use of the crop, the maximum soil moisture deficit which can be tolerated before production is adversely affected and the effect of an irrigation free period. Varietal differences and the paucity of replications, two only were possible, tended to cloud the issue. It was however noticeable that the irrigation free period treatment in which no water was applied from the end of the rains until the end of August resulted in a much lower yield within the same varieties than continuous irrigation produced. Irrigation at a factor of .8 × open pan evaporation is probably quite adequate to meet the crops water requirements, no increase in yields was obtained by using a higher factor.

(b) At Masenjere

INTRODUCTION

Towards the end of 1959 it was decided to establish a larger plot of cocoa in order to observe the performance of cocoa in an area adjacent to the Elephant marsh and on a soil type more akin to those which would be met in the marsh. Consequently a suitable area was found bordering on the Milole Stream at Masenjere and clearing and preparation of the irrigation layout was undertaken during November–December, 1959. The system employed was of the contour-check type because of the considerable slopes encountered and the system is so far proving satisfactory.

Cocoa seed arrived in early January, 1960, and was planted without delay. Though there had not been time to establish windbreaks or temporary shade and in the first few months the irrigation channels were not satisfactorily completed still germination and early growth was a great deal better than expected. Subsequent to the planting of cocoa, Pigeon Pea was planted to provide temporary shade and rows of bananas established at intervals throughout the plot to give temporary protection against strong winds. Later rows of cassia trees were planted along the two longest sides of the plot in order to afford more permanent windbreaks.

GROWTH

Despite the rigorous conditions that the young plants were subjected to, early and subsequent growth has been encouraging. Throughout 1960 and early 1961 the Pigeon Pea shade grew rapidly as did the banana windbreaks. So rapid was the growth of the shade that considerable shade reduction was necessary in June, 1961. The Pigeon Pea shade was entirely removed and replaced by seedlings of *Glyricidia maculata* and *Albazzia lebbec*. Of the main types of cocoa planted, viz., Upper Amazon, Trinitario and Amelonado, the Upper Amazon varieties have in all cases shown the most rapid growth and by the time the trees had reached two years old many flowers and a few cherelles were appearing. The development of both the Trinitario and Amelonado varieties has been slower. Many trees in all types exhibited abnormal leaf symptoms from an early stage, the commonest forms being chlorosis and sickle leaf. Limited investigations did not uncover the cause of these peculiar leaf phenomena. However, as the trees develop these symptoms tend to become less evident and it would not appear that growth was seriously retarded.

PESTS AND DISEASES

These have not been prevalent. No fungal attacks were observed and only one serious insect attack was recorded. This occurred in June–July, 1961, when it was observed that extensive damage was being done to young shoots and flushes by a sucking insect. Black lesions appeared on the affected parts and caused young flush growth to quickly wilt and fall off. A number of insects feeding on the cocoa were collected but it was not possible to establish clearly which species was responsible for the damage. The damage caused was however similar to that occurring widely in West Africa and there known to be the result of capsid attack. Spraying the trees with a solution of Aldrin 40 per cent. wettable powder at a concentration of 1 oz. per two gallons of water applied twice with a 22-day interval between sprays proved effective in clearing the pest. Occasional attacks by various types of aphids have been observed but on normal healthy trees the attack has not required treatment. On trees which were less vigorous, particularly amongst the Amelonado varieties, aphids did on occasion seriously curtail new growth. Such attacks were easily controlled by spraying with a weak solution, 7 mls. per 2 gallons water, of Rogor.

By the end of the year under review a few pods had been harvested from some of the Amazon varieties, flowering was profuse and indications were that in its third year of growth a sizeable crop would be produced.

Extract from Report of the Entomologist

New records of insects (all Hemiptera) from the experimental cocoa plots in the Lower River are as follows: *Pachybrachius bowesbarya* Dist., *Geocoris liolestes* Hesse, *Piesma dilutus* Stal, *Phenice* sp. nr. *stellata* Boh., *Peregrinus maidus* Ashm. and *Selenocephalus tenebrosus* Dist. No evaluation of the pest status of these insects, or of the insect complex on cocoa in the Lower River has been possible, but no insect has yet proved to be a serious pest. A certain amount of leaf-eating, leaf curl, yellowing of leaves, tip-boring and damage to stems causing lesions has been found due to various insects, but damage has been relatively small and the trees have all grown away from attacks (*see* also Annual Reports, Part II, 1959/60; 1960/61).

ESSENTIAL OILS

Ninde

1. OIL PERCENTAGE

Owing to pressure of work all samples submitted from Chitedze had to be bulked for distillation, so only an average percentage for this station was obtained.

Chitedze : on wet flowers as harvested, 1.37% crude oil and 1.18% redistilled oil.

Mbawa : on wet flowers as harvested, 0.53% redistilled oil.

Mlanje : on air dry flowers sent by post, 0.73% redistilled oil. There was a considerable amount of leaf and excess stem in the material harvested in this sample.

The crude farm still used for the initial distillation at Mbawa may account for the low percentage of oil from that station.

2. TIME OF PLANTING AND HARVESTING

At Chitedze, duplicate plots were planted out at different times and each time of planting was harvested on one day when approximately two-thirds of the flowers were found to have fallen. Results shown in Table I indicate that, as might be expected, the earlier the crop is planted out the bigger will be the first year crop.

At Mbawa, harvesting was done in several stages, as the flowers became ripe. A list of the dates, weights and oil % is given below for each time of plucking. As would be expected from selective pluckings of mature flowers the % of oil does not vary in any regular pattern.

Harvested	*lb.*	*Oil*
13/4/62	22.0 ..	.52%
17/4/62	9.5 ..	.51%
24/4/62	129.0 ..	.49%
28/4/62	150.0 ..	.58%
8/5/62	158.0 ..	.48%
12/5/62	154.0 ..	.57%

TABLE I

Effect of Time of Planting and of Fertilizer on Ninde Oil Yields at Chitedze

Treatment	Date Harvested	Days	*Yield/acre lb. fresh flower heads*	*Oil yield lb./acre*
Date planted				
8/12	21/5	165	1,800	21.2
22/12	7/6	167	1,090	12.8
4/1	12/6	159	850	10.0
19/1	19/6	151	490	5.8
Fertilizer treatments				
O – Nil			1,350	16.0
N – 200 lb./acre S/A			950	11.3
P – 200 lb./acre single supers			1,510	17.8
NP – 200 lb./acre of both			1,330	15.7

3. FERTILIZER APPLICATION

Duplicate observation plots of four fertilizer treatments were applied to Linde planted out at Chitedze on 14.12.61. Yields given in Table I above indicate that nitrogen may have a depressing effect on male flower production. The soil was a slightly phosphate deficient but otherwise fertile soil of the Kanjilima series.

ROTATION TRIALS

1. "ACRE" BLOCKS OF CONTINUOUS MAIZE CULTIVATION, ETC.

The block at Chitedze, in its seventh year on Lilongwe series soil, received 5 [illegible] 2:3:1 at 125 lb./acre single superphosphate and 200 lb./acre sulphate of ammonia. The yield of Mtukula maize was above average at 3,830 lb./acre grain.

The [illegible] at Mlowa, in its [illegible]th year on London series soil, received [illegible] 2:3:1, 125 lb./acre single superphosphate and 200 lb./acre sulphate of ammonia. The yield of Mtukula maize was 2,960 lb./acre grain, a considerable decrease [illegible] soil is [illegible]. The [illegible] acre block and the Maize/Groundnut rotation [illegible] Mtukula gave, in their third year, 1,430 lb./acre Arkeri maize grain, and 710 lb./acre groundnuts respectively. Continuous yields have steadily declined since these plots were started; maize yields fluctuate.

The acre block of maize at Chitala, in its fourth year on Chitala series soil as a [illegible] block, received 5 tonnes F.Y.M., 200 lb./acre single superphosphate and 200 lb./acre sulphate of ammonia. The yield of Mtukula maize was 1,860 lb./acre [illegible] The similarly treated block on a maize/cotton rotation gave 3,230 lb./acre grain, about average. A continuous cotton block, blanket sprayed against Bollworm, gave 700 lb./acre of A637 seed cotton of which 12.8 per cent. was Grade II. Exhaustion plots similar to the above but unfertilized gave in their seventh year 330 lb./acre maize, 780 lb./acre maize and 210 lb./acre cotton respectively.

The acre block at Tuchila, which receives only 200 lb./acre sulphate of ammonia each year, gave in its fifth year 3,140 lb./acre grain, about average for the field.

2. TWO YEAR ROTATION TRIALS

These trials are [illegible] block experiments with a large number of replicates, and run for two seasons. In the first year a series of crops is grown in each replication, and their effect on certain test crops is measured in the following season by planting three [illegible] complete [illegible] to each of the chosen test crops. Two trials were completed this season, one at Tuchila (unfortunately sited in a very waterlogged spot) and one at Chitala (also on a rather wet site).

TABLE I

Effect of Crop on Crop

Yield lb./acre maize grain, shelled groundnuts or seed cotton

Preceding Crop , *Station* / *Test crop*	*Tuchila*	*Chitala*			
	Maize	*Maize*	*Groundnuts*	*Cotton*	
				Yield	*Grade II*
Maize	1,050	620	1,240	1,100	23.5%
Maize + 200 lb./acre S/A	1,130	760	1,020	1,280*	18.9%
Groundnuts	1,340	1,470*	1,130	1,390*	24.2%
Green Manure	1,540*	1,460*	1,100	1,480*	24.3%
Cassava	1,010	750	1,210	1,150	21.0%
Sesame	—	910	1,230	1,220	23.7%
Cotton	—	680	1,240	930	24.1%
L.S.D. 5%	300	630	300	290	—
Mean	1,210	950	1,170	1,220	23.1%
Coefficient of Variation	24.2%	28.5%	10.7%	13.4%	—

The results are more or less as expected. Green manure gives the best yields in maize and cotton, but not in groundnut test crops, but the increase is not normally so great that it can in the short term be set for the loss of a cropping season. Groundnuts in the short run give nearly as good results in following test crops of maize and cotton. In areas where cotton and groundnuts are grown in each crop the rotation groundnuts, maize, cotton is probably best, without fertilizer equivalent being applied to the maize. If surface structure tends to deteriorate, the land placed at minimum cultivation under Cassava, Castor or Sesamum is to be advocated. Such suggestions apply to the more or less clayey soils in hot areas at about 1,700–2,000 ft. a.s.l., i.e. Salima Lake-shore and Palombe plain.

3. MPHANJE "C" EXPERIMENT, CHITEDZE

This experiment, a randomized block experiment with four replicates and split plots (for fertilizer treatments) laid out on [illegible] soil at Chitedze, was intended to provide some information on the productivity of the various combinations of the two maize, one legume and one tobacco that occur in the normal arable rotation used on the station, and to test the effectiveness of the fertilizer treatments applied. The four fertilizer treatments were applied in the first three seasons, the fourth being an unfertilized test crop of maize.

TABLE II

Yield Data on Mphanje "C" Experiment, Chitedze

Treatments Rotation and Fert. treats	*Total productivity in four years from* 2 acres *Maize* +	1 acre *G. Nuts* +	1 acre *Tobacco*	*Maize test Crop in 4th year—No fert. Yield: lb./acre grain*
	Maize lb. grain	*Groundnuts lb. shelled nuts*	*Tobacco lb. cured leaf*	
Fertilizer Sub-treats meaned				
A Mz., G.N., Tob., Mz. ..	6,920	1,100	670	3,930 after Tob.
B Mz., Tob., G.N., Mz. ..	7,600	910	590	4,460 after G.N.
C G.N., Tob., Mz., Mz. ..	7,000	1,800	710	2,590 after Mz.
D G.N., Mz., Tob., Mz. ..	8,650	1,680	680	4,010 after Tob.
E Tob., G.N., Mz., Mz. ..	7,790	1,010	820	2,960 after Mz.
F Tob., Mz., G.N., Mz. ..	8,260	940	790	4,060 after G.N.
L.S.D. 5%	—	—	—	260
Total Fertilizer applied per acre over whole 4-year period				
1—Nil	6,730	1,200	575	3,450
2—300 lb. S/A + 200 lb. "C" Mixture	7,990	1,190	845	3,670
3—400 lb. Single Supers only ..	7,750	1,260	540	3,830
4—300 lb. S/A + 200 lb. "C" + 400 lb. Supers..	8,340	1,260	880	3,740
L.S.D. 5%	—	—	—	160

TABLE III

Economics of Rotations and Fertilizer Treatments, Mphanje "C"

A. Total value of crops produced by each rotation, the expenses being approximately the same for each

	Maize @ 1d/lb.			G.-Nuts @ 4½d/lb.			Tobacco @ 1s per lb.		
	A	B	C	D	E	F			
†	£82.96 ..	£78.23 ..	£98.42 ..	£101.54 ..	£92.39 ..	£91.54			

B. Economics of fertilizer application using figures in Table II

Increases from	*S/A + "C" applied*	*Supers only applied*	*S/A + "C" + Supers applied*
Maize	1,265 @ 1d = £5.27	1,025 @ 1d = £4.27	1,610 @ 1d = £6.71
G-Nuts	Nil = £0.00	60 @ 4½d = £1.12	60 @ 4½d = £1.12
Tobacco	270 @ 1s = £13.50	Nil = £0.00	305 @ 1s = £15.25
Total Increase ..	£18.77	£5.37	£23.08
Cost of fertilizer @ 3d/lb.	£6.25	£5.00	£11.25
Cash return 4 acres ..	£12.52	£0.37	£11.83
Return/acre ..	£3.13	£0.09	£2.96

+ Divide by 4 to get gross output per acre per annum.

Though the comparison of rotations is rather confused by seasonal variations, as the experiment was not phased in time, the following points may be noted.

1. Although there were differences in output between the six rotations during the first three years, Quest Woodland Loam soil to account for the very large differences in yield of the maize test crop (on say rotations E and F). These differences in the test crop year are largely due to the preceding crop (Maize in E and Groundnuts in F—*see* Table II).

2. The unfortunate effect of starting the arable break with maize after ploughed [illegible] (unfertilized) and the advantage of starting with groundnuts.

3. The best order appears to be groundnuts, tobacco, maize, maize, or cash crop, maize, cash crop, maize.

4. Even in the best rotation gross output is only £25 per acre per annum.

5. Even when Lilongwe series soil becomes phosphate deficient as this was, it does not pay to splash on too much phosphate.

3. ROTATION EXPERIMENT NUMBER THREE

In 1961/62, rotation experiment No. 3 entered its first test crop year both at Chitedze on Lilongwe series soil and at Mbawa on Loudon series soil. It has previously undergone a six-year cycle at Chitedze and an eight-year cycle at Mbawa. The experiment is a complex factorial design best analysed as a 2^4 factorial, with additional control treatments, each main plot being split into two sub-plots to carry O and NP or N and P fertilizer treatments. It deals basically with two levels of each of two organic manures, plus Nil plots, combined with a cropping cycle of continuous maize compared with a cycle of half Maize, half Rhodes grass ley. The test crop was *unfertilized* maize. As this is an important experiment which will, it is hoped, throw light on the organic matter requirements of two markedly different soil types, it is proposed to publish the results in detail elsewhere and so only a brief summary is given here. Besides the yields of the test crop, there are given in Table IV an estimate of the mean productivity per acre per annum (of maize only) during the cycle, and the mean figures for soil C, N, P, K and pH for each treatment sampled at the end of the first cycle. The comparison of mean productivity between treatments with ley and those without ley is somewhat imperfect. A weighting factor has had to be applied to the continuous maize yields in the second half of the cycle, as there is no compensation for seasonal and management variations from year to year built into the design, and these have been considerable, especially at Mbawa.

TABLE IV

Main Effects of Organic Manurial trial Rotation No. 3 at Chitedze and Mbawa

Variety: Asikari (Mbawa) and Namlenga (Chitedze) *Yield: lb./acre grain/annum*

Treatments	Chitedze (Lilongwe series)							Mbawa (Loudon series)						
	Mean Product	Test Yield	pH	%C	%N	P. ppm	K me %	Mean Product	Test Yield	pH	%C	%N	P. ppm	K me %
A. *No Organic Manure applied*														
No Ley ..	2,590	2,780	6.1	1.88	.142	8	.49	780	630	5.7	.57	.050	63	.80
Ley .	1,480	2,810	6.0	1.97	.154	4	.45	480	1,300	5.9	.87	.058	68	.55
O .. .	1,790	2,710	6.1	1.90	.145	6	.49	480	1,230	5.9	.59	.054	54	.44
N	2,060	2,590	6.0	1.97	.151	6	.48	780	1,460	5.7	.63	.056	51	.44
P .. .	2,020	2,860	6.1	1.95	.151	6	.48	480	1,360	5.8	.64	.053	79	.40
NP .. .	2,260	3,040	6.0	1.88	.144	7	.42	770	1,210	5.7	.63	053	78	.42
B. *Organic Manure applied*														
No Ley ..	2,990	2,810	6.2	1.96	.151	10	.64	1,660	1,690	6.3	.88	.078	82	.58
Ley	1,530	3,310	6.1	2.04	.153	7	.53	1,000	2,770	6.2	.81	.077	78	.62
O	2,860†	3,050	6.2	1.98	.154	6	.59	1,760†	2,100	6.3	.84	.074	70	.64
N	3,240†	2,720	6.1	1.99	.152	8	.55	2,240†	2,370	6.2	.85	.080	66	.61
P	3,040†	3,010	6.2	1.98	.148	12	.66	1,870†	2,320	6.2	.87	.080	96	.58
NP	3,310†	3,060	6.1	1.96	.153	8	.59	2,200†	2,110	6.2	.84	.077	88	.58
C. *Organic Manures in absence of Ley*														
O	2,590	2,780	6.1	1.88	.142	8	.49	780	630	5.7	.57	.050	63	.80
C^1	2,870	2,610	6.3	1.91	.142	12	.57	1,620	1,560	6.2	.78	.073	85	.49
C^2	2,970	2,790	6.2	2.00	.151	8	.62	2,130	2,140	6.3	.92	.082	95	.61
D^1 .. .	2,860	2,960	6.2	1.95	.149	7	.61	1,020	1,100	6.3	.80	.069	72	.55
D^2	3,280	2,900	6.3	1.99	.161	12	.78	1,860	1,950	6.3	1.02	.088	77	.67
D. *Organic Manures in presence of Ley*														
O	1,480	2,810	6.0	1.97	.154	4	.45	480	1,300	5.9	.87	.058	68	.55
C^1	1,460	3,180	6.1	1.99	.153	7	.46	880	2,130	6.2	.74	.063	84	.57
C^2	1,470	2,990	6.0	2.04	.153	10	.52	1,310	3,310	6.3	.92	.086	89	.64
D^1 .. .	1,510	2,970	6.1	2.05	.145	7	.56	750	2,360	6.1	.72	.074	73	.58
D^2	1,670	3,310	6.2	2.08	.162	6	.57	1,060	2,700	6.2	.87	.082	67	.71

† These figures are for the first half of the cycle only, as the confounding makes the fertilizer totals not strictly comparable when the ley is down.

The treatments applied at each station and certain details of soil and manure analysis are given in Table V.

TABLE V

Details of Experimental Treatments

Treatment	*Chitedze (Lilongwe series)*		*Mbawa (Loudon series)*	
	Maize plots	*Rhodes grass plots*	*Maize plots*	*Makarikari plots*
N.	75 lb./acre S/A	200 lb./acre S/A	75 lb./acre S/A	200 lb./acre S/A
P.	100 lb./acre Supers	200 lb./acre Supers	100 lb./acre Supers	200 lb./acre Supers
C_1	2½ tons Compost	Nil	2½ tons Village Kraal Manure	Nil
C_2	5 tons Compost	Nil	5 tons Village Kraal Manure	Nil
D_1	2½ tons F.Y.M.	Nil	2½ tons F.Y.M.	Nil
D_2	5 tons F.Y.M.	Nil	5 tons F.Y.M.	Nil
Treatment of Ley ..	—	Rhodes grass cut for hay in Feb. and June	—	Makarikari cut cut short March
Treatment of Stover ..	Burned	—	Burned	—
Initial Soil analysis ..	*Sampled Oct.* 1954 S.C.L. pH 6.3, C = 2.0, N = 0.15, P = 56† K = .51, B.E.C. = 13.6 Base Sat. 85		*Sampled October* 1954 S.L. pH 6.2, C = 0.9, N = 0.08, P = 175† K = .18 B.E.C. = 6.8 Base Sat. 65	
Sample analysis C. ..	Mean of 3 samples Moisture = 9.0% On Dry Matter:— N = 0.28% P = 0.092% K = 0.16%		Not sampled	
Samples analysis D. ..	Mean of 3 samples Moisture = 64.2% On Dry Matter:— N = 1.70% P = 0.34% K = 1.86%		Not sampled	

† These values of P were obtained by a different method from that used for P in Table IV, and they should be multiplied by a factor 0.2 to make them approximately comparable.

It should be noted that the treatments involving a ley have received considerably more artificial fertilizer and less organic manure than those under continuous maize cultivation. The rates of artificial fertilizer were altered as experimental data available indicate that the levels applied to the maize would be a waste of fertilizer if applied to grass. The 200 lb./acre is the standard recommendation for leys, where fertilizer is required.

(*a*) At Chitedze, yields were higher, effects were less marked and the soil was richer than at Mbawa, except in the case of phosphate which was borderline at Chitedze and plentiful at Mbawa.

(*b*) Yields at Chitedze were maintained even on the continuous maize plots without ley or organic manure (provided some fertilizer was applied) but they tended to drop at Mbawa in spite of improved variety and cultivation.

(*c*) Under continuous maize cultivation without ley or organic matter, soil nutrients at Chitedze were slightly depleted [illegible] at Mbawa the losses [illegible] except in the case of phosphate, were heavy. At Chitedze leys tended to neither [illegible] but raise N and C, while application of organic manure raised all soil nutrient levels. At Mbawa, leys tended to raise K, C and pH (in spite of the [illegible] of sulphate of ammonia), but the organic manures were [illegible] more effective [illegible] apparently all the soil factors and the yields.

(*d*) Leys unutilized for livestock purposes reduce the mean productivity per acre almost in the proportion of ley to arable cropping in the rotation [illegible]. Nevertheless leys can, if suitably fertilized, maintain soil fertility as measured by a test crop, about as well as an annual dressing of 2–3 tons/acre of organic manure (compare rows 2 and 7 in Table IV).

(*e*) The compost at Chitedze was markedly inferior to the F.Y.M. used [illegible] rather low grade) and did little to improve yields. The open [illegible] at Mbawa was, however, more effective [illegible] than the F.Y.M. It is unfortunate that no analyses of these manures were recorded.

(*f*) At Chitedze there appears to be nothing to [illegible] continuous cropping for six years without ley or organic manure provided that adequate fertilizer is used, and that this is not badly unbalanced with respect to soil [illegible]. A [illegible] ley appears to be as effective as an annual dressing of 3–4 tons/acre of F.Y.M. in maintaining yield level, provided that extra phosphate is added to the soil when the ley is ploughed. The Lilongwe series is a fertile well-buffered soil, and with good farming techniques and only a small input in fertilizer it should be easy to maintain a test crop yield potential of 15 bags/acre maize without resorting to [illegible] or long leys. A very much higher production is, of course, possible.

(*g*) At Mbawa a ley or liberal use of organic manure is necessary if a reasonable yield potential is to be maintained, and of these the organic manure is the more effective provided that sufficient is put on—about 5 tons/acre per annum. By using both, a test crop yield potential of 15 bags/acre could be maintained. In either case the use of small quantities of artificial N and P is assumed.

(*h*) The levels of artificial fertilizer applied are so low that it is not easy to tell to what extent yields could be maintained by them alone. At Mbawa a ley or F.Y.M. is almost certainly necessary, though a good response will always be obtained from an application of nitrogen, and on some sites to an application of phosphate, however much organic matter is returned. At Chitedze the low levels applied gave increases comparable to those of the organic manures and ley, and it is possible that on this soil type crop production with fertilizer, but without organic manure or ley, could be continued for considerably more than eight years.

(*i*) There was no marked difference between the times of application of the organic manure, which were either in September or just before the rains in November.

It is unfortunate that in the present design the interactions between the fertilizers and the levels of organic manure used are confounded. However, by eliminating certain comparisons and unconfounding the remaining interactions, it is hoped to get more evidence on the fertilizer/organic matter interactions in the second cycle.

Rotation Trials, Makanga

(i) Rotation Trial 8/10. The results for the first five years are given in Table VI. In the fertile soils of Makanga as one would expect no obvious trends are as yet becoming evident and the trial will have to be continued for some considerable time.

(ii) Rotation Trial 8/11. The results of this trial since its inception are given in Table VII. Treatments 3 to 7 were incorrectly cropped in 1960. The difference in yields so far would seem to be more the result of annual variations in climate rather than treatment effects.

TABLE VI

Rotation Trial 8/10, Makanga

Yields in lb./acre Seed Cotton, Shelled Maize and Shelled Groundnuts

Phase	*Treatment*	1957/58	1958/59	1959/60	1960/61	1961/62
		(Cotton)	(G/nuts)	(Maize)	(Cotton)	(G/nuts)
A	1. Continuous Cropping 3 course rotation ..	450	991	897	1,009	345
	2. as above with F.Y.M. one year in three ..	411	854	1,510	1,142	308
	3 3 years crops 3 years bush fallow	428	759	1,010	fallow	fallow
	4. 3 years crops 3 years bush fallow .. .	fallow	fallow	fallow	945	348
	L.S.D. 5%	103	81	465	427	48
	Coef. of Var.	15%	19%	23.6%	24.0%	8.4%
		(G/nuts)	(Maize)	(Cotton)	(G/nuts)	(Maize)
B	1 Continuous Cropping 3 course rotation ..	888	2,646	802	941	2,456
	2 as above with F.Y.M. one year in three ..	932	2,125	715	907	2,166
	3. 3 years crops 3 years bush fallow	892	2,390	fallow	fallow	fallow
	4. 3 years crops 3 years bush fallow .	fallow	fallow	846	893	2,565
	L.S.D. 5% ..	103	367	197	203	581
	Coef. of Var. ..	7%	18%	14.4%	12.9%	14%
		(Maize)	(Cotton)	(G/nuts)	(Maize)	(Cotton)
C	1. Continuous Cropping 3 course rotation ..	3,481	680	428	2,032	1,226
	2. as above with F.Y.M. one year in three ..	3,532	855	409	1,537	922
	3. 3 years crops 3 years bush fallow .	3,430	fallow	fallow	fallow	970
	4. 3 years crops 3 years bush fallow ..	fallow	872	506	2,138	fallow
	L.S.D. 5% ..	242	163	213	517	399
	Coef. of Var. ..	4%	23%	27.6%	15.7%	22.2%

TABLE VII

Continuous Cropping Trial 8/11, Makanga, Summary 1958-62

Yield of Seed Cotton, Shelled Maize and Shelled Groundnust in lb./acre

Treatment		1958	1959	1960	1961	1962
1. Continuous Cotton ..	Crop	Cotton	Cotton	Cotton	Cotton	Cotton
	Yield	562	1,227	882	1,061	1,497
2. Continuous Maize ..	Crop	Maize	Maize	Maize	Maize	Maize
	Yield	3,8[illegible]	[illegible]	4[illegible]	[illegible]	2,565
3. Maize/Cotton (Phase I)	Crop	Cotton	Maize	Maize	Cotton	Maize
	Yield	538	2,994	607	1,074	2,565
4. Maize/Cotton	Crop	Maize	Cotton	Cotton	Maize	Cotton
(Phase II)	Yield	3,920	1,313	778	2,506	1,639
5. Maize/Cotton/Legume	Crop	Cotton	Legume	Legume	Maize	Cotton
(Phase I)	Yield	593	533	307	2,331	1,609
6. Maize/Cotton/Legume	Crop	Legume	Maize	Maize	Cotton	Legume
(Phase II)	Yield	896	3,258	717	1,174	399
7. Maize/Cotton/Legume	Crop	Maize	Cotton	Cotton	Legume	Maize
(Phase III) ..	Yield	3,690	1,273	718	—	2,844
Maize L.S.D. 5% ..	—	424	320	81	803	835
C. of V. ..	—	6.5%	12.0%	7.8%	19.3%	18.2%
Variety ..	—	Mlonda	Mlonda	Mlonda	Mlonda	Mlonda
Cotton L.S.D. 5% ..	—	146	156	260	210	160
C. of V. ..	—	15.9%	14.2%	19.0%	11.2%	5.8%
Variety ..	—	A637	A637	A637	A637	A637

(iii) Exhaustion Plots. Maize topped one [illegible] plots were maintained for maize and cotton. Yields to date are given in Table VIII. The cotton crop was sprayed once with D.D.T. 50 per cent. wettable powder at the end of February to control a heavy American bollworm attack. The maize crop suffered from the long drought in February and early March. Subsequently much of the crop was laid with strong winds in mid-March and consequent termite attacks on laid cobs reduced yields.

TABLE VIII

Yield of Exhaustion Plots, Makanga

	Maize yield in lb./grain per acre	*Cotton yield in lb. seed cotton per acre*	
1954	896	—	
1955	1,755	—	
1956	Floods	Floods	
1957	1,780 Makanga Selections 100 lb. S/A acre	1,000	
1958	2,106 Makanga Selections	500	
1959	1,780 Mlonda	1,470	A637
1960	707 Mlonda	614	A637
1961	1,350 Mlonda	709	A637
1962	965 Mlonda	1,030	A637

Cultivation Trials

RIDGING AND MULCHING TRIAL

This trial, a 3×3 factorial of six replications, compares three levels of mulching, viz:—

M_0 no mulch

M_1 3.7 tons dry mulch/acre

M_2 7.4 tons dry mulch/acre

and three levels of cultivation, viz:—

C_0 normal hoeing, no ridging

C_1 normal hoeing, ridging alone

C_2 normal hoeing, ridging and boxing and all their interactions.

In its ninth year the trial was planted to groundnuts but due to the poor quality of seed and lack of supplies for refilling a poor crop resulted and no treatment differences were shown.

Table IX contains a summary of the mean yields for the main treatments and it will be seen that except in a year of very high rainfall (54/55) and in a year of partial crop failure (61/62) mulch produced very significant responses. Ridging alone did not significantly increase yields while ridging and boxing generally did, but not to the same extent as mulching. There was no additional benefit in combining boxing and mulching.

TABLE IX

Ridging and Mulching Trial: Yields of seed Cotton, shelled Groundnuts and shelled Maize in lb. per acre

Year	53/54	54/55	55/56	56/57	57/58	58/59	59/60	60/61	61/62
Crop	Maize	Maize	Cotton	Maize	Cotton	G/nuts	Maize	Cotton	G/nuts
Rainfall Nov./Apr. in.	20.97	37.96	23.43	28.29	20.63	27.48	20.77	24.80	32.92
Date of Planting	10 Dec.	30 Nov.		29 Nov.	3 Dec.	11 Jan.	29 Dec.	8 Dec.	20 Dec.
Flat	383	1,483	floods	2,121	804	423	1,337	1,367	231
Ridged	551*	1,448	destroyed	2,304	783	466	1,553	1,238	207
Ridged and Boxed	734*	1,515	crop,	2,436*	814	589*	1,767*	1,395*	232
No mulch	344	1,489	stalk	1,825	705	358	768	933	250
Light mulch	602*	1,534	weight	1,102*	876*	529*	1,857*	1,476*	187
Heavy mulch	722*	1,426	indicated	2,935*	821*	610*	2,034*	1,591*	233
L.S.D. 5%	127	—	response	234	96	126	513	272	94
Coefficient of Variation ..	33%	—	to mulch	15%	17.8%	22%	49.1%	30.5%	31.4%
Interaction	—	—	—	not sig.	significant negative interaction box × mulch				

In 59/60 and 60/61 ridging and boxing was significant only in the absence of mulch.

CHEMICAL WEED CONTROL

1. MAIZE CHEMICAL WEED CONTROL TRIALS

These trials are designed to find out the technique and obtain an estimate of the profitability of the use of 2,4-D as a pre-emergence and post-emergence weedicide. To this end five treatments were laid out in randomized blocks with four replicates at each of three sites. The weedicide was applied at the rate of 2 lb./acre active ingredient. Details of treatments were varied between sites to fit in with seasonal variations. These detailed treatment differences are listed below the yield figures in Table I.

TABLE I

Effect of Weedicide Treatments on Maize Yields

Treatment	*Chitedze*	*Chitala*	*Mbawa*
Soil series	Lilongwe	Chitala	Loudon
Climate typified	Lilongwe/Dowa	Salima Lake-shore	South Rukuru
Date planted	18/11	6/12	27/11
1 Minimum weeding	4,480 (Banked 19/1)	1,140 (Banked 8/2)	1,030 (Hoed 3/2)
2 Clean weeding	5,040 (Hoed 14/12 and 19/1)	1,900 (Hoed 9/1 and 8/2)	4,600 (Hoed 7 times 9/12–5/4)
3 Pre-emergence spray	5,090 (Sprayed 20/11)	1,120 (Sprayed 9/12)	1,220 (Sprayed 2/12, weeds hand pulled 19/2)
4 Pre-emergence spray plus weeding	5,080 (Sprayed 20/11 and banked 1/2)	1,620 (Sprayed 9/12 and banked 8/2)	2,480 (Sprayed 2/12 and hoed 13/1)
5 One weeding plus post-emergence spray	4,470 (Hoed 19/1 and sprayed 19/1)	1,850 (Hoed 6/1 and sprayed 8/1)	4,210 (Hoed 30/12 and sprayed 18/1)
L.S.D. 5%	490	270	820
Mean	4,830	1,530	2,710
Coefficient of Variation	7.6%	13.2%	22.7%

The pre-emergence sprays were not as effective as they might have been as there were early heavy rainstorms at Chitedze on November 5th and at Mbawa on November 17th. Grass weeds germinating and surviving from these early storms were not affected by the rate of 2–4D applied. At Chitala and Mbawa treatment 5 gave the cleanest stubble and yields not significantly less than the clean weeded control. At Chitedze, the early weeding on this treatment was left much too late, and as a result gave a yield no better than the minimum cultivation control, though the stubble was clean. Where rains break with a rush and the land is not too foul, it is possible to get away with a pre-emergence spray alone, though the stubble is left very weedy. Where planting rains are preceded by a series of moderate showers, treatment 5 is probably the safest bet, but the hoeing must be *early*. Weed species to be controlled are largely annual grasses.

2. GROUNDNUT CHEMICAL WEED CONTROL PLOTS

These trials were of exactly similar design as those on Maize, but they were conducted at only two sites and the 2-4D was applied at the rate of only 1 lb. acre active ingredient. The rate of application did not harm the groundnuts, but it only controlled the weeds that were just germinating at the time of application.

TABLE II

Effect of Weedicide Treatments on Groundnut Yields

Variety: Mwitunde and Dixie Runner — *Yield: lb./acre shelled nuts*

Treatment	*Chitedze planted* 11/12		*Mbawa planted* 25/11	
	Yield	*Dates of treats*	*Yield*	*Dates of treats*
1 Minimum weeding	630	30/11	800	5/2
2 "Clean" weeding	1,200	14/12 and 18/1	1,040	8 and 30/12, 14/1, 5/2
3 Pre-emergence spray ..	1,040	20/11	720	2/12
4 Pre-emergence spray plus hoeing	1,120	20/11, 18/1	1,020	2/12, 13/1
5 Hoeing and post-emergence spray	1,400	30/12 and 18/1 19/1	1,040	30/12 and 13/1 18/1
L.S.D. 5%	80		70	
Mean	1,080		920	
Coefficient of Variation ..	5.6%		5.6%	

Pre-emergence spray at 1 lb./acre active ingredient 2-4D alone is not sufficient to give near maximum yields, but when combined with a hoeing in January will give yields not significantly different from the two hand hoeings. Weed competition late in the season can reduce yields by half.

The main weed species recorded at Chitedze were as follows:—

Monocotyledons	*Dicotyledons*
Eleusine indica—Chinsankwe	*Ageratum conyroides*—Cinusi
Rotboellia exultata—Msonthe	*Vernonia* sp.—Kapanthi
Rhyncheletrum repens—Utululu	*Nicandra physaloides*—Chambwinja
Eragrostis sp.—Kambwerere	*Vernonia cinerea*—Chamasala

3. WEEDKILLER TOLERANCE TRIAL WITH LEGUMES

With a view to extending the pre-emergence weedkilling with 2-4D from the maize fields to the legume fields at Chitedze, the more important legumes grown on the station were planted at four different dates on soil sprayed once early in the season at rates of up to 4 lb. acre active ingredient. Owing to the early rainstorms the weedicide was not wholly effective against the grass weeds, especially at low concentrations, and all plots were weeded and banked on 16th February. Spray was applied on 29th November and the late planted plots were hand weeded before seed was sown.

TABLE III

Tolerance of Various Legumes to Pre-Emergence Sprays of 2-4D

	Groundnuts (Mwitunde)		*Bambarra Groundnuts*		*Cowpeas*	
	% germination	*Yield/acre lb. seed*	*% germination*	*Yield/acre lb. seed*	*% germination*	*Yield/acre lb. seed*
S_0 No spray	90.0	1,320	90.9	360	90.4	290
S_1 1 lb./acre a.i. 2–4D ..	76.8	1,250	74.3	430	87.2	240
S_2 2 lb./acre a.i. 2–4D ..	90.2	1,320	81.0	530	88.4	290
S_4 4 lb./acre a.i. 2–4D ..	84.5	1,460	82.2	470	80.5	290
P_1 Planted 27/11 ..	89.7	1,590	84.8	630	90.1	430
P_3 Planted 7/12 ..	92.4	1,630	92.3	370*	81.8	330
P_3 Planted 18/12 ..	80.0	1,350	80.2	280*	88.5	290*
P_4 Planted 28/12 ..	77.2	780**	72.0	530	86.0	100*
L.S.D. 5%	—	400	—	230	—	140
Coefficient of Variation	—	28.2%	—	48.7%	—	47.2%

	Soya Beans		*Bush Beans*		*Jack Beans*	
	% germination	*Yield/acre lb. seed*	*% germination*	*Yield/acre lb. seed*	*% germination*	*Yield/acre lb. hay*
S_0 Nil	80.8	680	93.1	680	96.8	13,160
S_1 1 lb./acre a.i. 2–4D ..	75.6	820	95.0	430	90.1	12,870
S_2 2 lb./acre a.i. 2–4D ..	79.9	730	92.5	480	94.7	12,200
S_4 4 lb./acre a.i. 2–4D ..	73.3	730	93.2	430	86.0	12,150
P_1 Planted 27/11 ..	82.8	1,110	92.6	730	88.6	18,340
P_3 Planted 7/12 ..	78.3	770*	92.7	430*	89.1	10,600*
P_3 Planted 18/12 ..	84.8	580*	93.8	480*	95.8	11,520*
P_4 Planted 28/12 ..	64.6	480*	95.2	390*	93.5	9,100*
L.S.D. 5%	—	330	—	180	—	5,600
Coefficient of Variation	—	42.0%	—	34.3%	—	45.0%

There were no significant interactions between rate of spray and time of planting. Comments on the various crops may be made as follows:—

(*a*) Groundnuts (Mwitunde). Pre-emergence weedkiller had very little effect on the germination of the nuts at any of the rates applied. Yields were not affected either. The usual reduction in yield due to late planting is noted.

(*b*) Bambarra groundnuts or Nzama (Mbawa D). Pre-emergence weedkiller had little effect on the germination of seeds planted at various times after spraying, and there was no difference between the rates of 2–4D applied. Yields were all low and were affected more by the time of planting, than by spray treatments.

(*c*) Cowpeas (Mwazisi). There was only a slight reduction in the germination percentage, notably in the crop planted one week after spraying, and there was very little difference in germination between the rates of weedkiller applied. Yields were unaffected by the 2-4D but dropped rapidly as the planting date became later. The crop was severely damaged by leaf-eating beetles and then by Ring spot disease (*Ascochyta* sp.).

(*d*) Soya beans (Volstate). Pre-emergence weedkiller application reduced the germination percentage slightly though there was little difference between rates of spray. Yields were, if anything, increased on sprayed plots, due to a measure of weed control. Late planting reduced yields.

(*e*) Bush beans (Canadian Wonder Small). Pre-emergence weedkiller had no effect on the germination percentage, but appears to have stunted the plants in later growth and so reduced the yield. This reduction occurred in all plantings and is not greatly affected by the rates of 2-4D applied. Late planting also reduced yields.

(*f*) Jack beans (Canavalia). Pre-emergence spraying slightly reduced the germination percentage of seeds planted up to 2 weeks after spraying. Yields were affected mainly by time of planting. The crop was badly damaged by leaf-eating beetles in January, but managed to recover after being sprayed with D.D.T.

IRRIGATION

Makanga

1. INTRODUCTION

The objects of the irrigation studies at Makanga were fully described in last year's report and still remain basically the same. The range of crops grown has been narrowed slightly and the main efforts of the limited staff directed toward the three crops cotton, sugar cane and cocoa though a number of other crops still find a place in the rotation. Soil moisture studies have been continued but apart from the collection of meteorological data little progress has been made in the field of evaporation studies.

2. CROPS AND YIELDS

No new annual crops were tested and work on existing crops in the normal rotation curtailed in order to devote more time and space to the major crops. The results of this work are brought up to date in Table I and show that yields in nearly all cases have been maintained and in some cases increased. Potato yields have fallen, largely due to the unsuitable local seed. The castor crop planted in the dry season ran to rank vegetative growth and set very little seed.

New introductions of linseed were tried on a very small scale; the most promising varieties will be bulked up and introduced again into the rotation. Wheat and rice in earlier years did not show promise and are no longer grown. Prices shown are current local prices for the period.

The more permanent crops, sugar cane and lucerne, are reported elsewhere as are the tree crops cocoa and citrus. Of a number of other tree crops introduced three or four years ago tea did not thrive and has died out while robusta coffee does seem to have some possibilities. Cashew, Avocado, Mango and Oil palm have all made satisfactory growth and are beginning to bear. Timber trees have been established and those resisting the severe termite attacks are making excellent growth, *Eucalyptus tereticornis* being the most promising of the Eucalypts while *Grevillea arborea* has also grown well.

3. AGRONOMY OF IRRIGATED CROPS

(a) Water Rates and Frequency of Irrigations—Winter Crops

(i) *Beans (Canadian Wonder ex Kirchhoffs).* A 3^3 factorial trial of 27 plots in three blocks to test the effect of low, medium and high water rates, irrigations at 1 inch, 2 in. and 3 in. deficits and three spacings was laid down over gypsum resistance blocks. Within the spacings tried there was no significant differences in yield, effects of irrigation rates and frequencies of irrigation are shown in Table II.

TABLE I

Yields and Values of Irrigated Annual Crops at Makanga

Crop	1961 *Dry Season*			*To Date Since 1956 (6 years)*			
	Date planted	*Weighted mean yield per acre*	*Index*	*Weighted mean yield per acre*	*Total acreage*	*Price to farmer*	*Gross return per acre*
Maize	9/ 5/61	2,357 lb.	1.68	3,321 lb.	4.88	1¼d/lb.	£18
	11/ 8/61						
Beans (Kidney)	21/ 7/61	1,386 lb.	.84	1,120 lb.	3.09	4d/lb.	£19
Grams (Black)	10/ 8/61	624 lb.	.42	585 lb.	1.35	5d/lb.	£12
Grams (Green)	10/ 8/61	653 lb.	.42	653 lb.	.42	4d/lb.	£11
Onions	15/ 5/61	16.56 tons	.84	10.05 tons	3.51	3d/lb.	£[illegible]
Potatoes	26/ 4/61	3.2 tons	.93	5.62 tons	[illegible]	[illegible]	£110
	1961/62 wet season						
Cotton	7/11/61	—	[illegible]				
	22/11/61	2,126 lb.	[illegible]	1,784 lb.	14.21	6d/lb.	£[illegible]
	16/12/61	—	[illegible]				
Maize	7/11/61	[illegible]	[illegible]	2,979 lb.	8.71	1¼d/lb.	£[illegible]
	28/11/61		84				
Groundnuts	21/11/61	875 lb.	[illegible]	913 lb.	4.85	5d/lb.	£[illegible]

TABLE II

Yield of dried Beans in lb. per acre

Irrigation Rates	*Deficits*			*Mean*
	1 in.	2 in.	3 in.	
I_0	1,107	1,378	1,142	1,208
I_1	1,426	1,450	1,279	1,384
I_2	1,713	1,559	1,367	1,546
Mean	1,415	1,461	1,261	—

L.S.D. 5% Margin 269
,, ,, Body of table .. 466
C. of V. 19.5%

The amounts of water applied were:
I_0 .. 11 inches
I_1 .. 15 ,,
I_2 .. 20 ,,

The extra water applied in the highest water rate was not reflected in a significant increase in yield nor did the most frequent irrigations produce an expected increase in yields. Soil block readings revealed that beans can draw water extensively from the second foot of profile.

(ii) *Onions.* A similarly designed trial (3^3 factorial) to find optimum water rates, frequency of irrigation and spacing was carried out on a crop of onions variety Texas Grano. The treatments were:—

Irrigation rate I_0 0.6 Evaporation Open Pan
I_1 1.0 ,, ,, ,,
I_2 1.4 ,, ,, ,,

Frequency of Irrigation F_0 1 inch deficit
F_1 2 in. ,,
F_2 3 in. ,,

Spacing, 4 in. between plants in rows 12 in. apart
,, ,, ,, 15 in. ,,
,, ,, ,, 18 in. ,,

Again the spacings within the range tried produced no significant differences in yield. The effects of irrigation rates and frequency of irrigation are shown in Table III.

TABLE III

Yield of Onions in tons/acre

Irrigation Rates	*Deficits*		
	1 in.	2 in.	3 in.
I_0	16.19	17.14	16.69
I_1	15.35	17.55	18.81
I_2	15.32	17.53	14.23

L.S.D. 5% 3.85
Coefficient of Variation 13.3%

The crop was severely attacked in the latter stages by *Alternaria* sp. and there was a very significant correlation between frequency of irrigation and incidence of fungal attack. This it is believed masked the probable response to more frequent irrigation treatments at low water rates. The indications are that frequent irrigations at the highest water rate are not desirable. The crop was planted over gypsum resistance soil blocks and weekly readings revealed that with a factor of 0.6 E_0 water stress in the first foot of profile occurred frequently especially at the peak leaf and bulb formation stage while the factors 1.0 E_0 and 1.4 E_0 kept the first foot of profile at a uniformly low moisture tension throughout. In the low water rate treatment there was no evidence of the crop drawing on moisture reserves in the second foot of profile.

(iii) *Maize.* Two trials were carried out to find the maximum permissible soil moisture deficit that can be allowed to accumulate at various stages of the crop's growth before the performance of the crop is affected and at the same time to observe changes in soil moisture status in the profile in relation to frequency of irrigation. The trials were laid out in a randomized block design and the standard practice of irrigating throughout the crops duration when a calculated deficit of 2 in. is reached was used as control. This was compared with irrigations at various deficits at various stages of growth and irrigations at a 4 in. deficit throughout.

In the first trial which was planted in May and harvested in September, a period of low evaporation, standard practice proved best but did not produce yields significantly better than irrigations at a 4 in. deficit. Irrigations at a 1 inch deficit depressed yields, the frequent irrigations causing poor soil aeration. In the second trial which was planted in August and harvested in December before the onset of the rains, a period of very high evaporation, standard practice again proved best. Whole irrigations at 4 in. deficits reduced yields but not significantly so. Regarding the 4 inch frequency, in the first crop soil moisture reserves were higher, evaporation rates lower and moisture stress reached less frequency than in the second crop when the converse was true. This would suggest that it is possible to produce good crops of maize with an irrigation frequency of 4 in. provided soil moisture reserves in the profile are adequate and provided the peak water requirements of the crop do not coincide with a period of very high evaporation.

(b) Water Rates and Frequencies of Irrigation, Supplementary Irrigated Summer Crops

(i) *Maize.* The findings of the previous trials were further tested during the rains when another trial was laid down. The treatments were irrigations at deficits of 2 in. and 4 in. in a randomized block design with 15 replications. A summary of findings is given in Table IV.

TABLE IV

Yield of shelled maize in lb./acre

Treatment	*Yield*
T_1 Irrigation at 2 in. deficit	3,232
T_2 Irrigation at 4 in. deficit	3,348
L.S.D. 5%	293
Coefficient of Variation	11.4%

T_1 has four irrigations, T_2 one irrigation and therefore made fuller use of the high rainfall. Soil moisture blocks revealed no moisture stresses in the profile in either treatment at any stage of the crop.

(ii) *Cotton.* Water usage by the cotton crop was investigated in two trials and the findings are recorded under the section of this report dealing with irrigated cotton.

(iii) *Permanent Crops.* Rates and frequencies of irrigation for cocoa, sugar cane, citrus and lucerne are described under each crop heading later in this report.

Fertility Studies of Land Under Continuous Cropping and Irrigation

The three fields laid down to long term fertility trials were cropped as follows:—

Fd.	Experiment	1961 (5th dry season)	1961/62 (6th wet season)
A	3^3 NPK	Castor	Cotton
B	3^3 NPK	Grams	Maize
C	3 levels F.Y.M.	Potatoes	Groundnuts

In field A the castor crop ran to gigantic vegetative growth and little seed was produced. Grams in field B gave a mean yield of 640 lb. per acre and potatoes in field C yielded poorly owing to unsuitable seed and a severe attack of bacterial blight. There were no significant responses to any fertilizer in either field A or B but potato yields did respond significantly to farm yard manure.

Field A planted to cotton in the wet season gave a mean yield of 2,195 lb. seed cotton per acre, field B produced a mean yield of shelled maize of 2,111 lb. per acre while in field C, in which a groundnut variety trial was superimposed on the basic F.Y.M. treatments, yields of two of the three varieties just exceeded 1,000 lb. shelled nuts per acre. For the first time in this series of trials cotton showed a highly significant response to nitrogen. 200 lb. of sulphate of ammonia increased yields over the control by 535 lb. seed cotton per acre. This large response could be partially attributed to the high depletion of nitrogen by the previous cotton crop which grew to some 10 feet in height and was entirely removed from the field before preparation for the cotton crop. Maize yields in field B were actually depressed by the application of 200 lb. sulphate of ammonia per acre while groundnuts in field C did not respond to the residual effects of farm yard manure. In the final analysis after twelve crops have been taken in six years there is little evidence of loss of fertility, though with continual flood irrigation soil structure is worsening and seed bed preparation and establishment of crops is becoming more difficult.

COTTON

The pattern of rank vegetative growth and excessive flower and boll shed on summer grown supplementary irrigated cotton at Makanga is now well established. This year again a number of the possible causes were investigated. In one trial the effect on growth habit and yield of a number of factors was studied. These factors were, hormone flower set sprays, water regime and protection against insect pests. In a further small trial the possibility of excessive nitrogen causing rank growth was investigated along with the effects of pruning.

(i) *Root Environment, Water Regime, Hormone Spray and Protection Trial*

The treatments were as follows:—

Factor C Cultivations (Pre-planting)

- C_0 No cultivation, weed removal only
- C_1 Normal hoeing
- C_2 Subsoiling to a depth of 15 inches followed by hoeing.

Factor W Water Regime and Irrigation factors

	Pre-planting	Planting	Planting to flowering	Post Initial Flowering
W_0	Nil	2in.	0.3 × Open Pan	Nill
W_1	Nil	2in.	0.3 × Open Pan	1.6 × Open Pan
W_2	4in.	Nil	0.6 × Open Pan	Nil
W_3	4in.	Nil	0.6 × Open Pan	1.6 × Open Pan

Nil treatment represents no irrigation, rainfall only.

Factor H Spraying with Duraset 20W a plant growth hormone at first flower and again two weeks later.

Factor P Protection against insect attack with Seven 85S., 50% D.D.T. wettable powder and Rogor as required from first flower buds for a period of 12 weeks.

The trial was laid out on a split plot design with two replications. C treatments were allocated to main plots consisting of five irrigation basins. W and H treatments were allocated to sub-plots (single irrigation basins). The H treatment had the same water regime as W_0 and the P treatment was applied to one complete replication.

Cotton was planted on 7th November 1951 the spacing being 2 feet between single plants in rows 3 feet apart. Establishment was good in all plots, pre-planting and first planting treatments being overshadowed by a fall of 3.5 inches of rain on 9th November. Detailed daily records were kept of flowering, shedding and boll production on a sample of five plants in each sub-plot. Height measurements for the same plants were also recorded weekly. Dalapon 20W at a concentration of 100 p.p.m. was applied on 26th December and again on 8th January to sub-plots with this treatment. Spraying of the protected portion of the trial was done weekly with the appropriate insecticide. Frequent and heavy rain during the latter half of December and throughout January tended to reduce the effectiveness of a number of the spray applications.

The first pick was taken on 9th March and the last on 4th July though all the crop had been removed from the sprayed portion by May 18th. The yield data is given in Table V and as would be expected in a year of high rainfall, good planting rains already mentioned, 23 inches in the first three months of the crop and over 30 inches total during the life of the crop, no significant responses were shown by any of the higher irrigation treatments. Soil blocks revealed that even in the treatments having virtually no irrigation only slight moisture stresses occurred and for very short periods. February and early March were dry but soil moisture reserves were by this time adequate to maintain satisfactory growth. The lower yields resulting from normal hoeing cultivation are believed to be caused by differences in fertility between one side of the experimental area and the other. No increase in flowering, boll set, nor seed cotton production resulted from the use of the plant growth hormone spray, its effect may have been masked by the extremely wet season and excessive vegetative growth of the crop. Although it was not possible to compare statistically protection against insect pests with no protection, the higher yield and better grade of cotton produced on the protected area are evident.

TABLE V

Root Environment, Water Regime, Hormone Spraying and Insect Control Trial

Yield of seed cotton in lb. per acre

Cultivations	*Water Regime and Hormone Spraying*					*Mean*
	W_0	W_1	W_2	W_3	H	
C_0	2,061	2,411	2,034	2,225	2,025	2,151
C_1	1,884	1,743	1,616	1,643	1,566	1,691
C_2	2,256	2,048	2,334	2,334	2,252	2,245
Mean	2,067	2,067	1,996	2,067	1,948	2,029
L.S.D. 5%	C Mean 549		W. Means 174		Body of table 301	

C. of V. Error (*a*) 14.1% Error (*b*) 6.8%

		%*Gd. I*	%*Gd. II*
Rep. I no insect control	yield in lb./acre	1,875	55	45
Rep. II Insect control	,, ,, ,,	2,182	77	23

Flowering, Shedding and Boll Production Data

Although a vast amount of data was collected on the above the excessively heavy rainfall early and late in the season reduced nearly all treatments to a common denominator. The most outstanding difference shown was the effect of spraying against insect pests. This practice reduced mean plant height from 85 in. for unsprayed to 62 in. for sprayed plants. More than half the crop on the sprayed portion was picked before the first ripe bolls appeared on the unsprayed portion. There were no significant differences between rate of flowering and number of sheds as a result of the various water regime nor did hormone spray show any beneficial effect. The following table summarizes the main points.

TABLE VI

Flowering, Shedding and Boll Production Data

		Length of period weeks	*Protection*	*No Protection*
Date of planting	7th November	—	—	—
Flowers produced/plant ..	24th Dec.–26th March	13	81	120
Percentage flowers and bolls shed	24th Dec.–9th April	15	64.8	78.2
Split bolls collection/plant ..	28th Feb.–30th March	4½	19.6	nil
	31st March–11th May	6	5.1	14.2
	12th May–26th May	2	.2	2.3

By 26th May the crop was 7 months of age and late rains had encouraged late sympodial growth and continued flowering. Seven months would be the normal time allotted to a cotton crop in irrigation farming if a second crop is to be taken that year. Plots were harvested finally on 4th July but all cotton had been picked on sprayed plots by the end of May.

(ii) Pruning, De-Flowering and Restriction of Nitrogen Observational Trial

This trial was designed to throw some light on possible ways of controlling the excessively rank growth of irrigated cotton and to find the relationship if any between shedding and rank growth. The treatments were:—

1. Control, normal husbandry practices.

2. Reduction of available nitrogen by incorporating sufficient dry maize stover into the ridges before planting to reduce the available N. by 100 lb. acre.

3. Stopping all monopodial growth by pruning when the plants attain a satisfactory fruiting structure.

4. Removal of all flowers daily.

The trial was of a randomized block design with six replications; spraying against insect pests was done weekly from first flower buds for a period of eleven weeks. Cotton was sown on 12th November at a spacing of 2 ft. on ridges at 3 ft. intervals and subsequently thinned to 1 plant per stand. By 22nd January, i.e. after ten weeks, plants in treatment 3 had attained a mean height of 4 ft. 6 in. and an adequate fruiting structure so pruning was started and continued weekly until new growth ceased.

All flowers were removed daily in treatment 4 from 1.1.62 to 25.3.62, i.e. for a period of twelve weeks. The mean flower production per plant per day for this period was 2.0; in the twelfth week flower production had reached a daily rate of 3.2 flowers per plant, the plants a mean height of 85 inches. The plants were still growing strongly and since it was obvious that given adequate water they would continue to grow and to flower profusely this treatment was discontinued. In this trial excessive shedding was simulated by flower removal and it is suggested that excessive shedding can be a contributory factor to rank growth.

Treatments 1, 2 and 3 were continued till the end of the crop and showed no significant differences in rate of maturing of bolls nor in yield. A reduction in available nitrogen did not reduce plant height.

(iii) Irrigation Trial

The water requirements of the cotton crop were shown, from previous experiments to increase exponentially from 0.3E Open Pan at establishment to 1.6E Open Pan at 10 weeks when leaf area is at a maximum and reproductive activity is also high. Water use at this high factor continued for about six weeks (see 1960–61 Annual Report). A trial to compare the yield of cotton grown on rainfall only with a crop receiving supplementary irrigation as indicated by the above factors was planted on 16th December, 1961. The design was a randomized block with five replications.

In the six weeks before planting 7.37 inches of rain were recorded, 2.17 inches falling in the two days prior to planting. Establishment was good and routine spraying against insect pests was done weekly between the fifth and fifteenth week. The season as already stated was extremely wet and in the first 16 weeks of growth 24.11 inches of rain were recorded. Heavy January rains precluded the necessity of irrigating until the end of the eighth week of growth. From then until the sixteenth week 12 inches of water was applied to the irrigated treatment plots. The yields are given in Table VII and show that in this case supplementary irrigation reduced yields.

TABLE VII

Irrigated Cotton Trial, Makanga

Yield of Seed Cotton in lb./acre

Rainfall only	2,635
Rainfall plus Irrigation	2,333
L.S.D. 5%	280
Coefficient of Variation	6.5%

Gypsum resistance blocks inserted at 1, 2 and 4 feet levels below the crop revealed that the irrigation treatment did maintain soil moisture at low tensions, less than $\frac{1}{3}$ atmospheres throughout the profile during the sixteenth weeks. In the rain fed plots higher moisture tensions were built up from time to time in the top two feet of profile but at the four feet level there were adequate reserves of moisture. It may well be, and experience elsewhere suggests, that cotton may not thrive best in a soil which is at or near field capacity continually.

LUCERNE

Variable and conflicting findings have been reported in previous years especially concerning water use by this crop. The last crop grown was planted in August, 1960, and had thirteen cuts taken between that date and 7th January, 1962. At this stage weed population was high, in particular nut grass *Cyperus* sp. Weeding during the rains was not proving effective so the crop was ploughed out.

Three water rates were tested 0.8E Open Pan, 1.0E Open Pan and 1.2E Open Pan but statistical comparison of the resultant yields was not possible. Table VIII summarizes the findings:

TABLE VIII

Lucerne, Makanga

Irrigation (factors)	*Yield dry hay/acre*	*Cuts taken*	*Inches Irrigation Water Applied*	*Period*
.8 E Open Pan	10.17	13	83	Aug. 60–Dec. 61
1.0 ,, ,, ...	12.01	13	106	,, ,,
1.2 ,, ,, ...	10.26	13	132	,, ,,
Mean	10.81	13	107	

At the beginning of June, 1961, i.e. after 10 months, six treatments were superimposed on the experiment the object being to see if irrigations could be limited without reducing yields in view of the high requirements of other crops at this time. The treatments were withholding irrigations during June, June–July, August, August–September, October and October–November. It is probable that the trial did not run long enough to show the full effects of these treatments but from June, 1960, to final harvest in January, 1962, no significant yield differences were shown between treatments and the control which was irrigated throughout. The mean yield 10.81 tons/acre over a seventeen-months period is equivalent to .63 tons/acre/month or 7.6 tons/acre/year. It is suggested that if vigorous mechanical inter-row weeding and cultivation had been possible competition from weeds would have been greatly reduced and higher yields obtained.

CITRUS

The present citrus plot comprising .6 acres was planted in January, 1958, one half to Valencia Late Orange and one half to Mediterranean Sweet Orange. The trees are planted in irrigation basins each 70 sq. yd. in area and a comparison is being made between a density of one and two trees per basin. Vegetative growth has been satisfactory despite a certain amount of twig die back on the Mediterranean Sweet Orange and occasional chlorosis in the leaves of some trees.

During 1960, when the trees had attained a considerable size, there was still no sign of flowering. Irrigations at a factor of 0.8 E_0 had been applied when the calculated deficit had reached two inches and this water regime led to fairly frequent irrigations throughout the year. It is generally accepted that citrus must receive a check in growing conditions or rather pass through a period of dormancy in order to ensure flower setting. Since really low temperatures are never experienced in this area it was considered necessary to create a dormancy period by withholding irrigations at a suitable time of the year.

An observation trial embodying three water rates, two frequencies of irrigation and three non-irrigation periods was started in November, 1960. Because of the rather delayed action by tree crops to changes in treatment some time must elapse before treatment effects become marked. However, during late July, August and September, 1961, a considerable amount of flowering was evident particularly in plots which had no water applied between the end of the rains and end of August. In

February, 1962, a fruit count was made and revealed an excellent fruit set on these latter plots some trees carrying over 200 fruits, the Valencia Late Orange carrying a heavier crop than the Mediterranean Sweet Orange. No other treatment produced anything approaching this number of fruits per tree.

Shedding of fruit in small quantities began in February and by the beginning of April investigations showed that the numbers shed were abnormal and that the shedding was caused by two pests, *Argyroploce leucotreta* (False Coddling moth) and Trypetid larvae (Fruit flies) the latter being more in evidence. All fallen fruits were collected and destroyed daily from 1st April onwards and weekly sprayings of poison bast (sodium fluosilicate and sugar) applied between 9th April and 11th May. By this time however most of the fruit had shed and only a very small harvest was taken. The problem of pest control in the maturing fruit requires further investigation.

AGRICULTURAL CHEMISTRY

Investigations with certain specific crops are reported under crop headings; *see* oil seeds, cotton, tea, tung and coffee.

Soil Analysis

In connection with the survey to determine those areas where phosphate fertilizers would be beneficial to improve the quality of the native tobacco, 113 soil samples were taken from the various areas in the Central Province. In the Central Province, a figure of 8 p.p.m. had been taken as the critical limit, below which phosphate application was recommended. In the Southern Province, however, in only one village was the figure appreciably lower. It was therefore necessary to compare alternative methods of phosphate extraction. $N/_2$ ammonium fluoride is used as a general extractant, but where soil phosphorus levels are lower in the Central Province weaker ammonium fluoride with small additions of hydrochloric acid had given more selective data. However, with this extractant (on which the criteria of 8 p.p.m. is based) the Southern Province soils gave much higher values. The weaker ammonium fluoride was therefore used alone, in addition to the stronger as above. Comparative data for the available phosphorus determined by the two methods is given below:—

$N/_2$ NH_4F	13 ..	18 ..	31 ..	70 ..	119 ..	216 ..	348
.03 NH_4F + .025 NHCl ..	31 ..	26 ..	44 ..	114 ..	290 ..	352 ..	552
.03 NH_4F alone	9 ..	7 ..	18 ..	48 ..	57 ..	48 ..	62

Miscellaneous Problems

The usual range of fertilizer materials and water samples has been examined. Among these may be mentioned several domestic water samples from boreholes, containing colloidal iron oxide, which could be precipitated either by aeration or lime treatment. A sample of fish meal, in connection with a possible Lake-shore village industry, was found to contain 20 per cent. protein, 1 per cent. phosphorus and 3 per cent. calcium. There was, however, appreciable chlorous contamination, and improvement would have to be effected.

Micro-Nutrients Investigations

1. *Eucalyptus saligna* at Lusangazi and Mlanje which exhibited leaf tip necrosis showed the following micro-nutrient levels, all figures being in p.p.m. on a dry-weight basis:

	Aluminium	*Boron*	*Copper*	*Iron*	*Manganese*	*Zinc*
Lusangazi—normal ..	250	29	5.6	60	120.0	7.6
Lusangazi—affected ..	150	12	Trace	50	590	5.7
Mlanje—normal	n.d.	38	2.2	85	950	11
Mlanje—affected ..	n.d.	39	2.2	90	700	15

Boron and/or copper deficiency at Lusangazi was therefore suspected and the trees did respond to applications of borax. At Mlanje, deficiency symptoms appeared to be attributable to drought conditions, as they disappeared with the onset of the rains.

2. Micro-nutrient determinations on samples of normal and affected *Eucalyptus pilularis* from Lusangazi, showed little significance, although the affected leaves had generally lower levels:

	Aluminium	*Boron*	*Copper*	*Iron*	*Manganese*	*Zinc*
Normal	140	28	2.2	83	420	9.9
Affected	79	28	1.8	53	280	8.9

3. *Gmelina* leaves, normal and affected, from Chitedze were examined and compared with leaves from the same species from Chigamula. The affected leaves were displaying an intervenal chlorosis and a boron deficiency was suspected, the symptoms appearing in localized areas where hut sites may once have existed, leading to alkali concentration following burning. Again, the rains cleared up the symptoms. Levels were:

	Aluminium	*Boron*	*Copper*	*Iron*	*Manganese*	*Zinc*
Chitedze—normal ..	245	36	4.6	220	140	16
Chitedze—normal (adjacent to affected)	180	12	4.3	170	110	8.4
Chitedze—affected ..	200	12	4.0	170	120	14
Chigamula—normal ..	350	46	2.6	170	76	18

4. Determination of available copper and zinc in soils.

Initial work utilizing the conventional extractant, 2.5 per cent. acetic acid, showed this medium to be unsatisfactory from the viewpoint of subsequent polarographic analysis. Investigations with hydrochloric acid showed that a deci-normal solution extracted 60–80 per cent. of the copper and zinc removed by acid of 2N concentration. As the literature indicates good correlation between 2.5 per cent. acetic acid and 0.1N hydrochloric acid, it was decided to use acid of this strength, this being also very convenient for the subsequent polarographic determination.

Another extractant, 0.25M E.D.T.A. ("Versenate") showed good results for copper, but necessitated a separate determination for zinc and was therefore not continued with.

The effect of organic matter upon the "extractability" of copper and zinc has been studied, it being found that oxidizing the organic matter prior to determination has little significance with regard to the amounts found:

	Available copper, p.p.m.		*Available zinc, p.p.m.*	
Soil Organic Carbon, p.c.	*Not oxidized*	*Oxidized*	*Not oxidized*	*Oxidized*
0.4	2.4 ..	2.7 ..	3.8 ..	4.2
1.2	3.5 ..	4.4 ..	Nil ..	Nil
3.4	7.1 ..	5.8 ..	Nil ..	Nil

The ranges of copper and zinc levels of local soils so far studied are trace—6.8 p.p.m. (mean 3.5 p.p.m.) and Nil—4.0 p.p.m. (mean 1.1 p.p.m.). The zinc levels in particular are low but determining the total contents by means of potassium hydrogen sulphate fusions confirm them.

Samples of Northern Rhodesian soils taken in the Copper Belt have, of course, shown far higher levels.

Pasture Composition in Rains

Twenty-seven grasses from Bvumbwe were examined at the beginning of March (towards the end of the rains), and the data, for protein on a dry weight basis, is summarized below:

7–10 per cent. .. *Echinochloa devuli* (a)
Echinochloa pyramidalis
Phalaris tuberosa
Penniseteum purpureum (Gold Coast)
Paspalum dilatatum (Par.) (a)
Paspalum notatum
Eragrostis curvula (a)

5–7 per cent. .. *Echinochloa pyramidalis* (Chirunda)
Panicum hirtatum
Panicum schinzii
Panicum trichocladum (Kilaroi)
Setaria homonyma
Oryzopsis exigua
Digitaria diagonalis
Digitaria decumbens (a)

3–5 per cent. .. *Acroceras macrum*
Chloris gayana (Katambora, Mpwapwa, Rongai)
Cynodon dactylon (b)
Panicum subalbidum (creeping)
Panicum maximum
Paspalum notatum (Pensacola) (c)
Paspalum urvillei (c)

The composition followed very much the pattern reported last year. Where grasses came outside their previous group this is indicated by (b) for the very much lower, and by (c) for those slightly lower. Those higher than last year are marked (a).

THE REPORT OF THE PLANT PATHOLOGIST

During the year under review the Pathologist spent six months on leave. Two months of this were spent working in the Nematology Department of Rothamsted Experimental Station.

Tobacco

Tobacco Anthracnose (*Colletotrichum tabacum* Boning) did not appear in the Central Province growing areas in the year under review. Its appearance in one of these areas last year caused considerable alarm and after destruction of affected beds, a spraying scheme was instituted in order to prevent its spread in this, the main African tobacco growing area. In the Southern Province five outbreaks were reported, all on estates. No Anthracnose was found on Trust Land.

Alternaria leafspot, caused by *Alternaria tenuis* (Ell. & Ev.) Mason was widespread and did appreciable damage in the Southern Province, a tobacco growing area in which it rarely appears in epiphytotic form. The last two seasons, during which it has been widespread in the Southern Province, have been rather wetter than usual.

Tomatoes

Spraying trials for the control of *Phytophthora infestans* (Mont.) de Bary, the cause of Late Blight of tomatoes, were continued. Four fungicides were used. These were Captan (2 lb. 100 gal. acre), Zineb (2 lb./100 gal. acre), cuprous oxide (4 lb./100 gal. acre) and Bordeaux mixture (8 lb. 100 gal. acre) applied weekly and after every 2 in. rain. During the course of the experiment thirteen weekly sprays were applied and six sprays after every 2 in. rain. Two varieties were grown: Sunrise and Pearson. *Sclerotium rolfsii* killed some plants soon after transplanting, and later in the season *Cladosporium fulvum* and *Septoria lycopersici* were present as well as *Phytophthora infestans*. Some fruit was damaged by *Heliothis* sp., the American Bollworm. This was controlled by two sprays of Thiodan.

The results are presented below in summarized form.

Treatment Means in lb./acre

Captan		*Zineb*		*Cuprous oxide*		*Bordeaux*		*Control*
W.	2″.	W.	2″.	W.	2″.	W.	2″.	
2,982	2,856 ..	3,796	2,684 ..	3,056	3,021 ..	3,259	3,832 ..	1,949

Sig. diff. 5% = 573. Sig. diff. 1% = 780.

W. = weekly sprays. 2″. = sprays after every 2 in. rain.

Zineb weekly and Bordeaux mixture after every 2 in. rain were the two best sprays.

Of the two varieties used, Sunrise, with a mean yield of 4,311 lb./acre was significantly better than Pearson yielding 1,786 lb./acre. (Sig. diff. at 1% = 1,260.)

Tree crops

A brief survey of the incidence of *Armillaria mellea* on various tree crops was carried out during a visit by the Forest Pathologist, Kenya. Isolations made in culture and a series of field observations exhibited a range of symptoms and characteristics including many typical of *Clitocybe tabescens*. This work continues in the hope of explaining observed anomalies in the behaviour of *A. mellea*.

Coffee

This is reported separately in the Fusarium Scheme report.

Pinus Radiata

The disease decimating *P. radiata* plantings in Chikangawa Forest in the Northern Province has been identified as *Dothistroma pini* Hulbary a disease of needles which has suddenly appeared in several places in East Africa and which is causing severe damage, particularly to young plantings under about 10 years old.

Publications

An illustrated handbook of Queensland plant diseases has been prepared and is in course of printing. It is hoped that this book will enable the field staff of the Department of Agriculture to identify the common plant diseases and apply control measures without reference to the Pathologist.

"A supplementary list of Queensland plant diseases", including all new records made since the last one was published in 1962, has been prepared and submitted to the Commonwealth Mycological Institute for publication as a Mycological Paper.

Two papers have also been accepted for publication. These are: "Coffee bark diseases in Nyasaland. I. Description and identity of the causal organism." M. A. Siddiqi and D. C. M. Corbett. *Transactions of the British Mycological Society*. (In press.)

"The occurrence of *Criconemoides mavdorum* Taylor, 1936, in Central Africa." D. C. M. Corbett. Short note in *Nematologica*. (In press.)

New Records

New plant disease records for the year under review are as follows:

Afrormosia angolensis—Mwanga.

Butt rot: *Trametes* sp.

Mildew: *Uncinula incrassata* Salm.

Leafspot: *Pestalotiopsis* sp.

Leafspot: *Phaeosaccardinula canthii* (Hansf.) Hansf.

Leafspot: *Chaetopeltopsis* sp.

Aleurites montana—Tung.

Leafspot: conidial *Mycosphaerella aleuritidis* Ou

Brachystegia longifolia.

Mildew: *Uncinula* sp.

Leafspot: *Mycosphaerella* sp.

Leafspot: *Phaeosaccardinula canthii* (Hansf.) Hansf.

Camellia sinensis—Tea.

Leafspot: *Leptosphaerulina* sp. (Associated with *Colletotrichum* sp.)

Dieback: *Coniothyrium* sp.

Canavalia ensiformis—Jack bean.

Leafspot: *Ascochyta phaseolorum* Lib.

Citrus sp.

Dieback: *Sphaerostilbe flammea* Tul. (Associated with scale insect attack.)

Cocos nucifera—Coconut.

Leafspot: *Cladosporium* sp.

Cupressus lindleyi—Cypress.

Canker: *Monochaetia unicornis* (Cke. & Ell.) Sacc.

Canker: *Botryosphaeria dothidea* (Maug. ex Fr.) Ces. & de Not.

Delphinium ajacis—Larkspur.

Leafspot: *Cercospora* sp. (nr. *Canescens*.)

Dianthus caryophyllus—Carnation.

Leafspot: *Alternaria dianthicola* Neergard.

Glycine max—Soya bean.

Bacterial leafspot: *Xanthomonas phaseoli* var. *sojense* (Hedges) Star & Burk.

Grevillea robusta.

Leafspot: *Phyllosticta* sp.

Hippeastrum sp.—Xmas Lily.

Leafspot: *Stagonospora curtisii* (Berk.) Sacc.

Lycopersicon esculentum—Tomato.

Root rot: *Sclerotium rolfsii* Sacc.

Mangifera indica—Mango.

Algal spot: *Cephaleuros pulvinatus* Schmidle.

Musa sp.—Banana.

Leafspot: *Alternaria musae* Bouriquet & Bataille

Leafspot: *Epicoccum nigrum* Link

Phaseolus vulgaris—French bean.

Leafspot: *Phyllosticta* sp.

Pinus radiata—Pine.

Needle blight: *Dothistroma pini* Hulbary

Needle blight: *Lophodermium pinastri* (Schrad. ex Fr.) Chevall.

Needle blight: *Naemacyclus niveus* (Pers. ex Fr.) Sacc.

Prunus persica—Peach.

Leafspot: *Colletotrichum* sp.

Psidium guajava—Guava.

Algal spot: *Cephaleuros virescens* Kuntze.

Solanum melongena—Egg fruit.

Leafspot: *Cercospora melongenae* Welles

Leafspot: *Pseudoplea trifolii* (Rostr.) Petr.

Spathodea nilotica—Nandi Flame tree.

Root rot: *Armillaria mellea* (Vahl. ex Fr.) Quel.

Vitis venifera—Grapevine.

Mildew: *Uncinula necator* (Schw.) Burr. Present as *Oidium tuckeri*.

ENTOMOLOGY

This season two major pests reappeared after being unrecorded in Nyasaland for many years.

Red Locust (*Nomadacris septemfasciata*)

The Red Locust was first recorded in Lake Chilwa area on 18th July. Previously the last occurrence of this pest in numbers was in the years 1932 to 1944.

The present outbreak of Red Locust is confined to an area on the western littoral of Lake Chilwa between latitude 15° 0′ and 15° 15′ and longitude 35° 35′ and 35° 45′. Ground and aerial surveys disclosed no concentrations in any other area, but a solitary male was found near Chingoli, due west of Zomba, about 40 miles from Lake Chilwa as the locust flies. A search in the Chingoli area disclosed no other specimens. It was very approximately estimated that ten to fifteen million locusts were present in the Chilwa area.

With the co-operation of the International Red Locust Control Service at Abercorn, who provided an aircraft and pilot, the concentrations of locusts on the western shore of Lake Chilwa were sprayed from the air in early September. A trial using Sevin 85S was carried out and one grass island concentration was treated, but immediate ground examination showed that while some kill was obtained, the majority of the locusts were still flying and that the control was not very satisfactory.

A further trial was carried out using Sevin 85S in an odourless kerosene. Sevin was difficult to mix with the oil and, if left, separated almost immediately as was to be expected with this formulation. However, the agitator on the aircraft and the motion kept the insecticide in suspension and spraying was possible without clogging and with little deposit in the filter or tank.

The Sevin in oil was much more effective and gave at least three to four times the kill of Sevin in water. The droplet size was considerably smaller and the cover better.

Routine spraying was then carried out and the main concentrations were sprayed from the air. These concentrations were to be found on the *Typha* islands. Subsequent investigations showed that a good kill had been obtained and that the concentrations sprayed no longer existed, although a few locusts still flew up in the sprayed areas when disturbed by Land-Rover.

Scattered locusts were not sprayed, however, and it is possible that there is still a sufficient population to produce sizeable hopper swarms, although the danger of this has been greatly reduced by the control. The locusts are being kept under observation, and a supply of B.H.C. is on hand to enable any hopper swarm from the area to be dealt with. It seems likely that Lake Chilwa is a permanent breeding area and will be required to be watched every year in the future.

An informatory booklet entitled "Red Locust (*Nomadacris septemfasciata*) in Nyasaland", pp. 14, 7 figs., has been published giving the life-cycle and distinguishing characters of the Red Locust, and notes on the ecology of the Lake Chilwa locust region.

Pink Bollworm (*Platyedra gossypiella*)

The second major pest, Pink Bollworm, is discussed under the section on cotton (p. 61). A bulletin, "Pink Bollworm (*Platyedra gossypiella*) in Nyasaland," pp. 4, 3 figs., has been published.

BAMBOO (*Oxytenanthera abyssinica*)

A *Hispa* sp. (Hispinae) was found to be widespread and causing serious damage in February and March this season in bamboo groves and thickets in Central Province. No damage was found in Southern Province. The larvae are leaf miners and the adults feed on the epidermis of the leaf. This species, hitherto unrecorded in Nyasaland, caused most damage in the adult form by almost skeletonizing the leaves. Serious damage was found at Dedza, Mua Forest, Chiradzi, Lilongwe and Salima.

Sevin 85S at 0.025 per cent. gave a good control of the adults in dipping tests in the laboratory, but no field control has been attempted.

Pinus patula

Several pests have been recorded this season.

(*a*) *Buzura edwardsi* Prout (Geometridae). First record for Nyasaland. Final and penultimate stage larvae were discovered in numbers on Zomba Plateau at an altitude of between 5,000 and 6,000 feet. All these larvae pupated by mid-May, and investigations at that time showed that pupation was in the soil around the bases of the trees. Some empty pupal cases, apparently belonging to moths emerging normally, were discovered at the same time and in June. A proportion of the moths emerged in the dry season, therefore, although an estimated 80 per cent. had not emerged by the end of June.

Larvae pupating in the insectary (collected in April) emerged after periods of 19½ to 27½ weeks. This is a much longer pupal period than was found for the same species at Nakawa in Uganda (4 to 9 weeks), and there seems little doubt that there is a pupal diapause in Nyasaland.

In November a fairly extensive sampling was carried out, every tenth tree in the compartment being selected for sampling, and at the same time a random sample was taken through the compartment. The results showed that an approximate average of three live pupae per tree was present, 14 pupae being the greatest number present at the base of any tree. The infestation is considerably lower, therefore, than the 20 to 50 pupae per square yard found in Uganda (Technical Note No. 99 (62), Uganda Forest Dept., January, 1962).

The distribution of pupae was such that trees sampled near the perimeter of the compartment had over 60 per cent. of the pupae found, and the infestation was not found to penetrate the compartment for a depth more than about 20 to 25 trees.

The majority of the larvae pupating in April/May emerged in November/December both in the insectary (in dry soil cages and in wet soil cages) and in the field, indicating that the pupal diapause can extend for seven months or more. It seems likely that, under the conditions on Zomba Plateau, the species is univoltine; the eggs are probably laid from late December to late February and damage from larvae will occur from March onwards, but early stage larvae may appear before then.

There is no evidence at present that any natural enemies are present in sufficient numbers to exercise any appreciable control. Although it is not recommended that any chemical control measures should be taken at present, it seems that a solution of insecticide, poured or applied with a coarse spray, around the base of each tree would be the most economic and practical form of chemical control. One of the chlorinated hydrocarbon insecticides would seem an obvious choice and, as the pupating larva would be more susceptible than the emerging moth or the pupa once it is formed, the period to apply the insecticide would be in early April. It is not regarded as feasible to attempt to control the larvae or the adult moths by means of insecticides. To date the insect has been found to pupate not more than two inches deep in the soil and not more than about one foot away from the base of the trunk.

(*b*) *Dicastiews gerstaeckeri* Faust (Curculionidae). Small numbers of this weevil have been found defoliating *P. patula* on Zomba Plateau, Mingoli Forest, Mlanje Mountain and elsewhere. It occurs in the adult form in March, April and May, and only the adult is known to damage *P. patula*. There are a number of alternate hosts.

(*c*) *Mecostibus* sp. ?nov. (Acrididae). Considerable defoliation of *P. patula* was reported to the Forestry Department in December, 1961 in a private plantation established in 1954 near Cholo. The average height of the trees was about 35 feet, and the floor was virtually free from weeds under the closed canopy. Numerous grasshoppers were present in December but were mostly immature. Adult grasshoppers were found in January and copulating pairs were present at the end of January. Numerous grasshoppers were still present in March and early April and copulating pairs were seen. In March the weed cover on the floor was dense with grasses seven feet tall in places.

Severe defoliation of most of the trees in this plantation occurred between December and March, but some new regrowth was seen in March and by December, 1962, the plantation showed no signs of damage and no *Mecostibus* were found.

The grasshoppers climb up the trunk of the tree, as many as thirty being seen climbing up the trunk of a single tree in March, until they reach a branch with needles. The needles are cut through near the base and drop to the ground. The grasshoppers do not appear to eat a great deal but one grasshopper may cut through numerous needles and considerable damage is done. In March, it was estimated that there was an average of 40 to 50 grasshoppers per tree, although there may have been more as it was not possible to discover the numbers in the upper part of the canopy. No other plants were attacked by this species.

This grasshopper, a new record, was determined by the Commonwealth Institute of Entomology and appears to be a new species.

(*d*) *Bombycopsis venata* Butler (Lasiocampidae). Caused some defoliation in *P. patula* but was commoner on *Cupressus lindleyi* (*see* below).

(*e*) Lasiocampidae, gen. et sp. incog. Two larvae collected but not reared.

Cupressus lindleyi

Bombycopsis venata Butler (Lasiocampidae). This moth, first recorded in Annual Report, Part II, 1960/61, was found again in the same compartments of Luwawa Forest in October, 1962. The larvae were hand-picked as last year, but the Forester observed no further larvae after mid-November.

Brachystegia spp.

A Melolonthid beetle, as yet unidentified, was received from the Silviculturist at Lilongwe. The adult beetle feeds on the leaves of *B. floribunda*, *B. longifolia* and *Julbernadia paniculata*. It is reported that the local people frequently fell trees in order to collect these beetles, which occur in very large numbers at the beginning of the rains; the beetles are boiled and eaten as relish.

Gmelina arborea

Phymateus viridipes, a common grasshopper with a wide range of hosts, caused some damage to *G. arborea* in Central Province this season. A Saturniid and a Lymantriid were also recorded from *G. arborea*, a single specimen only in each case.

Cassia siamea

The Giant Scale, *Aspidoproctus pertinax* Newst., was recorded on this tree near Chileka; also on *Cassia* sp. near Limbe and Zomba.

Meliaceae

Hypsipyla sp. *robusta* Moore (Phycitidae) Larvae were recorded from Lilongwe and Mlanje attacking *Cedrela australis*, *C. toona*, *Khaya nyasica* and *K. grandifoliola*. The blue larvae are shoot-borers and the damage was first noted in June when the larvae were well-grown. Serious damage was caused to sapling trees up to some 15 feet tall, the worst damage being to *Khaya nyasica*. Although the infestation was limited and in some compartments only a few trees were attacked, it was reported by the Forestry Department that *K. nyasica* suffered severely in one compartment. Growth of the trees was retarded and many of the attacked trees were deformed, the larvae tunnelling along the growing shoots. Little is known about the bionomics of this species at present. It was hitherto unrecorded on any host in Nyasaland and may be a new species.

Mussidia albipartilis Hamp. (Pyralidae) is a similar species, also recorded from Meliaceae, and first recorded in Nyasaland in 1914. Several specimens were collected this season from *K. nyasica* but the insect did not occur in serious numbers.

Stored Product Pests

A steady improvement can be reported regarding the conditions of storage and control of pests of stored products. Again the chief problem concerning exporters is the lack of adequate storage space, although some firms have expanded their premises this season.

Some 40,000 tons of produce, mostly groundnuts, cassava and pulses, were inspected, and 1,050 phytosanitary certificates were issued. In addition, a further 25,000 tons of cassava and pulses were exported without phytosanitary certificates being required by the importer or exporter; much of this was inspected before railage.

Special emphasis was given by Produce Inspectors to general handling problems, cleanliness, prophylactic control with insecticides and the proper use of fumigants.

Some exporters have been able to follow advice and have begun to separate cassava from other produce. This has led to a considerable reduction in infestation of pulses, grains and oilseeds in store. Other exporters are unable, or unwilling, to keep cassava, pulses and grains separate as they lack sufficient space. The general standard of stacking and cleanliness of premises has greatly improved in all cases, however.

Advice has been given on the purchase and use of spraying, fogging and dusting equipment, and some firms, previously without any such equipment, have now purchased machines and have been persuaded to adopt a regular schedule of preventive control. Nevertheless a lot remains to be accomplished in this field and it is only due to pressure by the Produce Inspectors that many firms maintain a satisfactory standard; some exporters have yet to maintain a reasonable standard consistently. Another problem is to temper the enthusiasm of one or two exporters, recently convinced of the importance of preventive pest control, who are liable to want to apply too much insecticide, and could thus create a residual toxicity hazard to the consumer.

As more exporters are carrying out their own fumigation, a stricter watch is being kept on fumigation methods and materials to try and prevent faulty fumigation resulting, (*a*) in a poor kill, or, (*b*) in a hazard to the operators, workmen or others. An investigation is being carried out and spot-checks are being made during and after fumigation, when samples of fumigated produce are retained for examination.

Detailed instructions together with a spraying schedule were given to the Farmers Marketing Board this season, to ensure uniformity of treatment of groundnuts at all depots and markets throughout the country. This resulted in a marked improvement, and even unfumigated groundnuts held at various markets for long periods were found to be free from pests. Only one case of infestation was found;

this was a stock at Balaka close to severely infested and unfumigated maize. In previous years, with a considerably smaller groundnut crop, heavy infestations have occurred. This was due entirely to poor arrangements for storage and to lack of any standard of pest control, the local buyer dealing with infestations as he thought fit and often not taking any preventive action at all.

One of the chief causes of infestation of export produce this season was the passage from Mozambique through Balaka and Limbe railway stations in Nyasaland of Portuguese cassava root, cassava flour and maize. This produce was usually very heavily infested, and, as it was often delayed in that country, local produce in the same sheds or in nearby sheds, became infested; railway trucks were also infested. Seven Portuguese firms are known to be exporting through Nyasaland but are difficult to contact. Measures are being taken to control the passage of this produce in future.

A preliminary test of a commercial brand of aluminium phosphide fumigant (Delicia) was carried out this season. Delicia was found to be as equally efficient as Phostoxin, at present in use in this country, and can be recommended for fumigation of pests in small stacks, or silos, bins, etc.

The survey of pests of stored products and premises, commenced in 1960, continued this season. Two new produce exporting firms commenced business this season.

Records of pests additional to the list of recorded Nyasaland produce pests (Sweeney, March, 1962. Insect Pests of Stored Products in Nyasaland, appendix II), are listed below:

Apion cdmus Fst. Found occasionally in newly harvested cowpeas this season, but not in stored cowpeas.

Bostrychopsis villosula Lesne. In cassava roots, February, 1962.

Callosobruchus chinensis (L.). Commonest Bruchid in cowpeas this season.

C. maculatus (F.). Almost as common as above in cowpeas.

Cadra cautella (Wlk.). From tea in England exported from Nyasaland.

Piezotrachelus pallus Boh. Commonest weevil in cowpeas and pigeon peas in markets, but rare in stores.

Haplonyx brevicollis Gerst. (Tenebrionidae.) Probably adventitious, in some numbers in tobacco shed.

Euthyrrapha pacifica (Coq.) (Polyphagidae). Probably adventitious, in tobacco shed.

Piophila casei L. (Piophilidae). The Cheese Skipper, first recorded on imported cheese in 1929 in Nyasaland, was omitted from the list in Appendix II (Sweeney, 1962). This tiny black fly, the white, legless larvae of which jump, when disturbed, by bending in an arc and straightening suddenly, has been recorded several times this season from dried fish, cheese and meat. The life-cycle takes approximately three weeks in Nyasaland on dried fish (19 to 23 days recorded).

Zomba Insect Collections

Work has continued putting the collections into order, identifying specimens and incorporating new accessions, but only limited time has been available this season for this work. Some 250 species new to the collection have been incorporated during the year; of these over 100 are new records for Nyasaland, and several are new to science.

Notes on Pests

Paederus rufocyaneus (Staphylinidae) occurred in small swarms in June and July, but appeared to be considerably less common than in 1960. Some cases of vesication in humans were recorded (*see* also Ann. Rept. Pt. II, 1959/60, p. 203).

Cylindrothorax strangulata (Meloidae) was responsible for most, if not all, the many cases of blistering caused in February amongst residents in Zomba. Probably at least 20 people were affected and some children were severely blistered.

Phymateus viridipes (Acrididae) occurred in small swarms early in the year and damage was reported to ornamental plants and grasses in various parts of Southern and Central Provinces.

Orthezia insignis (Coccidae), or Lantana-bug, is still a serious pest in the Shire Highlands being found on numerous ornamental plants and several trees. The incidence of this pest in Zomba itself was lower than in the two previous years, however (*see* Sweeney, *Nyasa. Farm. and For.* 5 (4) 8–11, June, 1961, for an account of this insect and a list of Nyasaland hosts).

Icerya purchasi (Coccidae), the Australian-bug or Fluted-scale, was scarce this season generally, and much less common than last season. *Icerya seychellarum* was recorded on only two occasions (see Sweeney, *Nyasal. Farm. and For.* 6 (1): 20–25, for an account of these insects in Nyasaland).

Laphygma exempta and *L. exigua* the Army-worms, were not recorded in any numbers this season in any locality, although small outbreaks occurred. However, a large outbreak was reported in Dedza District in September, 1962, but no specimens were seen.

Some severe damage was done to *Agave sisalana* in October on a prison plantation in Zomba. The primary damage, due to an orthopterous insect attacking the outer cuticle of the leaves, had little effect on the fibres. Such damage could well be ignored but for the secondary symptoms, due to disease organisms and, to a lesser degree, sunscorch, which seriously weakened the fibres. In most cases only an inner whorl of leaves were affected, the outer leaves and the spike being undamaged. Unidentified orthopteron eggs were found in slits of some two inches in length in several leaves, the eggs being placed in a row in the slit so that half of each egg was exposed. *Cyrtacanthacris aeruginosa*, *Pseudorhynchus pungens* and a *Catantops* sp. were found in the sisal, and *P. pungens* was the commonest species present and thought to have been responsible for most of the primary damage.

" Plagues " of slugs (not identified) and snails (*Achatina* sp.) occurred in several places in the Shire Highlands during March. Slugs and snails, besides damaging many plants, were attracted also to buildings, presumably because cement is a good source of calcium which is often in short supply in soils and plants. Advice on the control of these gasteropods was given.

Earthworms gave some trouble in gardens this season in Zomba, since the above normal rainfall encouraged excessive multiplication. Several cases of flowering garden plants being damaged were recorded. In one case a successful control was obtained using two cupfuls of unslaked lime in three gallons of water, thoroughly agitating, and then allowing the mixture to settle and pouring the clear liquid on the soil.

Some damage to standing and stored crops on farms by rats was recorded. Most damage could be attributed to *Rattus natalensis* but *Cricetomys gambianus* was recorded on one occasion and this species is becoming more numerous as a pest of buildings according to the records. Normally it is a species living in forested areas near streams and is rare in buildings. Rodent damage in Nyasaland, while apparently normally of little consequence, has never been assessed or investigated.

Fruit and Vegetables

CUCUMBERS

Drosophila melanogaster Mg., *D. ananassae* Dol., *D. seguyi* Smart, *Dacus bevistylus* Bezzi and *D. vertebratus* Bezzi were recorded from cucumbers this season. Control of these Fruit and Pumpkin Flies was achieved this season in small holdings

using Lebaycid 50 per cent. emulsion at one ounce in four gallons of water. Three applications were found to be necessary, the first at flowering, the second when the fruits are still small and the third when the fruits are about half-grown (still green).

Where other fruits (especially peach or other fruit trees) occur in the vicinity, it is best to include them in the spray programme, and to ensure that a high standard of hygiene is maintained by spraying or burying all shed fruits. If this is done it might be possible to reduce the number of spray applications to two.

Do not spray Lebaycid within one week of harvesting the fruits.

CRUCIFERAE

Bagrada cruciferarum Kirk was recorded commonly this season in various gardens on cabbages mainly. A single application of D.D.T. 2.5 per cent. dust will give good control if applied when the bug is first seen. *Hellula undalis* F. was also common this season on cabbages, and may be controlled with D.D.T. spray.

DECIDUOUS FRUIT

The following species of fruit-flies have been recorded this season and identified by the Commonwealth Institute of Entomology: *Drosophila repleta* Woll. (peach trees, common); *D. simulans* Start (peach, banana flowers and ripe fruits, avocado pear); *D. nutrita* Duda (bananas); *D. praeinosa* Duda (bananas, avocado pear); *D. buskii* Coq. (banana flowers); *Zaprionus taiocrulatus* Malloch (banana flowers and ripe fruits, guavas, loquats); *Z. vittiger* Coq. (banana flowers), and an Ephydrid, species unknown (banana flowers; avocado pear).

It is probable that a spraying schedule using Lebaycid will give control of these fruit-flies, although no large scale control has been attempted. A good control was obtained in the case of two peach trees sprayed twice with Lebaycid at one ounce in ten gallons of water, and only approximately 10 per cent. and 18 per cent. loss of fruits was found compared with a total loss of fruits on one unsprayed tree. It seems likely that if the other trees in the vicinity had been sprayed with the insecticide, the damaged fruits on the two sprayed trees mentioned above would have been negligible. Treatment with Lebaycid has proved to be considerably more effective than the use of bait sprays incorporating Malathion as the insecticide.

CITRUS

Lepidosaphes beckii (Purple Scale) was recorded, apparently for the first time in Nyasaland, from citrus at Mzuzu. Control of this scale is difficult but it is not known to be serious on the limited amount of citrus grown in Nyasaland.

Spanioza erythreae (Citrus Psyllid) was found to be widespread this season in Southern Province, and serious damage to the leaves of some trees was found. Trees suffering from lack of water or planted in shallow soils were the worst affected, and damage was most serious from May to August.

MACHINERY

Groundnut Shelling Machine Tests

During the dry season a $2 \times 2 \times 2 \times 2 \times 2$ factorial trial with two replicates was conducted on the machine shelling of Mwitunde groundnuts from the 1961/62 crop. The treatments compared were:

.354 screen -vs- .375 screen.
Manufacturers shoe clearance, (c.$\frac{1}{2}$") -vs- adapted clearance (c. 1").
Manufacturers metal toothed shoes -vs- home made rubber covered shoes.
Junior Skylux -vs- Senior Skylux.

20 lb. samples were put through the Junior machine and 30 lb. samples through the Senior. The treatments were not completely randomized owing to the considerable increase in the amount of alteration of screens and other adjustments that would be entailed. In the second replicate the treatments were done in the reverse order of the first, in order to counteract as far as possible any effects the gradual drying might exercise upon the shelling characteristics of the groundnuts. Having been passed through the machines, the samples were hand winnowed and sieved over home made screens having oblong holes punched in aluminium of sizes 1" × $\frac{13}{64}$" and 1" × $\frac{17}{64}$". Each division was then sorted by hand into undamaged nuts, split nuts and those with broken seed coats. The $\frac{13}{64}$" screen let through most of the split and shrivelled nuts and retained what is considered should be a good saleable sample. The $\frac{17}{64}$ screen took out some of the smaller nuts, leaving a better looking sample in size, but no amount of sieving could remove whole nuts with damaged seed coats. Figures in Table I below show (*a*) the relative efficiency of the treatments in the shelling process, (*b*) the percentage of the shelled nuts falling into the marketable size grades, and (*c*) the percentage of split and damaged nuts in the marketable sample, made up very largely of damaged nuts which cannot be sieved out.

TABLE I

Effects of different adjustments on machine shelled samples of Groundnuts

Variety: Mwitunde

Treatment	(*a*) *% broken and split nuts in whole sample*	(*b*) *% sample passing over 15/64 screen*	(*c*) *% of split and damaged nuts in sample (b)*
A .354 screen	21.1	76.1	14.9
B .375 screen	15.7***	81.7***	10.5***
C Near clearance c. $\frac{1}{2}$"	23.3	74.1	14.1
D Far clearance > 1"	13.6***	83.7***	11.3*
E Metal toothed shoes	17.6	78.0	13.0
F Rubber shoes	19.2	79.8	12.4
G Junior Skylux	16.9**	77.1	14.9
H Senior Skylux	19.9	80.7*	10.5***
L.S.D. 5%	2.1	2.7	2.3
Mean	18.4	78.9	12.7
Coefficient of Variation ..	14.9%	4.6%	24.2%
Best treatment	BDEG 7.8%	BDEG 89.7%	BDFH 7.1%
Combinations	BDFG 9.5%	BDFG 88.0%	ADFH 7.7%
	BDEH 9.7%	BDEH 87.1%	BDFG 7.6%

On this showing, Mwitunde nuts need to be shelled with a .375 screen and a clearance between shoes and screen of a bit over 1". Rubber shoes tended to give more split and less damaged nuts than the metal ones, the net result being a slightly better looking sample from the rubber shoes, but less of it. Not much can be deduced about the relative efficiency of the two machines owing to the design of the experiment and the fact that the unshelled nuts were not in any way graded before being shelled. The best all round setting (BDEG or BDFG) gave a sample which, if sieved, gave an export sample of 90 per cent. of the crop, this sample containing less than 1 per cent. split nuts and 7–9 per cent. damaged nuts.

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